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NEW CHAPTERS IN THE WARFARE OF SCIENCE.

IX. THE ANTIQUITY OF MAN AND PREHISTORIC ARCHÆOLOGY.

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WHILE the view of chronology based upon the literal acceptance of Scripture texts was thus shaken by researches in Egypt, another line of observation and thought was slowly developed, even more fatal to the theological view.

From a very early period there had been dug from the earth, in various parts of the world, strangely shaped masses of stone, some rudely chipped, some polished; in ancient times these were generally considered as thunderbolts, and known as "thunder-stones." This idea was carried into the middle ages, and we find in the eleventh century an emperor of the East sending to the Emperor Henry IV, of Germany, a "heaven axe"; and, in the twelfth century, a Bishop of Rennes asserting the value of thunder-stones as a divinely appointed means of securing success in battle, safety on the sea, security against thunder, and immunity from unpleasant dreams: even as late as the seventeenth century a French ambassador brought a stone hatchet, which still exists in the museum at Nancy, as a present to the Prince-Bishop of Verdun, and claimed for it health-giving virtues.

Yet, as early as the latter part of the sixteenth century, Michael Mercati tried to prove that the "thunder-stones" were weapons or implements of early races of men, though from some cause his book was not published until the following century, when other thinking men had begun to take up the same idea.

But early in the eighteenth century a fact of great importance was quietly established: in the year 1715 a large pointed weapon of black flint was found in contact with the bones of an elephant,

in a gravel-bed near Gray's Inn Lane, in London. The world in general paid no heed to this; if the attention of theologians was called to it, they dismissed it summarily with a reference to the Deluge of Noah; but the specimen was labeled, the circumstances regarding it were recorded, and both specimen and record carefully preserved.

In 1723 Jussieu addressed the French Academy on The Origin and Uses of Thunder-stones. He showed that recent travelers from various parts of the world had brought a number of weapons and other implements of stone to France, and that they were essentially similar to what in Europe had been known as "thunder-stones": a year later this fact was clinched into the scientific mind of France by the Jesuit Lafitau, who published a work showing the similarity between the customs of aborigines then existing in other lands and those of the early inhabitants of Europe. So began, in these works of Jussieu and Lafitau, the science of comparative ethnography.

In 1730 Mahudel presented a paper to the French Academy of Inscriptions on the so-called "thunder-stones," and also presented a series of plates which showed that these were stone implements, which must have been used at an early period in human history.

In 1778 Buffon, in his Époques de la Nature, intimated his belief that "thunder-stones" were made by early races of men; but he did not press this view, and the reason for his reserve was obvious enough: he had already one quarrel with the theologians on his hands, which had cost him dear—public retraction and humiliation; his declaration, therefore, attracted little notice.

In the year 1800 another fact came into the minds of thinking men in England. In that year John Frere presented to the London Society of Antiquaries sundry flint implements found in the clay-beds near Hoxne; that they were of human make was certain, and, in view of the undisturbed depths in which they were found, the theory was suggested that the men who made them must have lived at a very ancient geological epoch; yet even this discovery and theory passed like a troublesome dream, and soon seemed to be forgotten.

About twenty years later Dr. Buckland published a discussion of the subject, in the light of various discoveries in the drift and in caves. It received wide attention, but theology was hushed to silence by his soothing concession that these striking relics of human handiwork, associated with the remains of various extinct animals, were proofs of the Deluge of Noah.

In 1823 Boué, of the Vienna Academy of Sciences, showed to Cuvier sundry human bones found deep in the alluvial deposits of the upper Rhine, and suggested that they were of an early geological period; this Cuvier virtually, if not explicitly, denied:

great as he was in his own field, he was not a great geologist; he, in fact, led geology astray for many years. Moreover, he lived in a time of reaction; it was the period of the restored Bourbons—of the Voltairean King Louis XVIII, governing to please orthodoxy. Boué's discovery was, therefore, at first opposed, then enveloped in studied silence.

Cuvier evidently thought, as Voltaire had felt under similar circumstances, that "among wolves one must howl a little"; and his leading disciple, Élie de Beaumont, who succeeded him in the sway over geological science in France, was even more opposed to the new view than his great master had been. Boué's discoveries were, accordingly, apparently laid to rest forever.*

In 1825 Kent's Cavern, near Torquay, was explored by the Rev. Mr. McEnery, a Roman Catholic clergyman, who seems to have been completely overawed by orthodox opinion in England and elsewhere; for, though he found human bones and implements mingled with remains of extinct animals, he kept his notes in manuscript, and they were only brought to light more than thirty years later by Mr. Vivian.

The coming of Charles X, the last of the French Bourbons, to the throne, made the orthodox pressure even greater. It was the culmination of the reactionary period—the time in France when a clerical committee, sitting at the Tuileries, took such measures as were necessary to hold in check all science that was not perfectly "safe"; the time in Austria when Kaiser Franz made his famous declaration to sundry professors, that what he wanted of them was simply to train obedient subjects, and that those who did not make this their purpose would be dismissed; the time in Germany when Nicholas of Russia and the princelings and ministers under his control, from the King of Prussia downward, put forth all their might in behalf of "scriptural science"; the time in Italy when a scientific investigator, arriving at any conclusion distrusted by the Church, was sure of losing his place and in danger of losing his liberty; the time in England when what little science was taught was held in due submission to Archdeacon Paley's doctrines and the Thirty-nine Articles; the time in the United States when the first thing essential in science was, that it be adjusted to the ideas of revival preachers.

Yet men devoted to scientific truth labored on; and in 1828

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* For the general history of early views regarding stone implements, see the first chapters in Cartailhac, La France Préhistorique; also Joly, L'Homme avant les Métaux; also Lyell, Lubbock, and Evans. For lightning-stones in China, see citation from a Chinese encyclopædia of 1662, in Tylor, Early History of Mankind, p. 209. On the universality of this belief on the surviving use of stone implements even into civilized times, and on their manufacture to-day, see ibid., chapter viii. For the treatment of Boué's discovery, see especially Mortillet, Le Préhistorique, Paris, 1885, p. 11.

Tournal, of Narbonne, discovered in the cavern of Bize specimens of human industry, with a fragment of a human skeleton, among bones of extinct animals. In the following year Christol published accounts of his excavations in the caverns of Gard; he had found in position, and under conditions which forbade the idea of after-disturbance, human remains mixed with bones of the extinct hyena of the early Quaternary period. Little general notice was taken of this, for the reactionary orthodox atmosphere involved such discoveries in darkness.

But in the French Revolution of 1830 the old politico-theological system collapsed: Charles X and his advisers fled for their lives; the other continental monarchs got glimpses of new light; the priesthood in charge of education were put on their good behavior for a time, and a better era began.

Under the constitutional monarchy of the house of Orleans in France and Belgium less attention was therefore paid by Government to the saving of souls; and we have in rapid succession new discoveries of remains of human industry, and even of human skeletons so mingled with bones of extinct animals as to give additional proofs that the origin of man was at a period vastly earlier than any which theologians had dreamed of.

A few years later the reactionary clerical influence against science in this field rallied again. Schmerling in 1833 explored a multitude of caverns in Belgium, especially at Engis and Engihoul, and found human skulls and bones closely associated with bones of extinct animals, such as the cave bear, hyena, elephant, and rhinoceros, while mingled with these were evidences of human workmanship in the shape of chipped flint implements; discoveries of a similar sort were made by De Serres in France and Lund in Brazil; but, at least as far as continental Europe was concerned, these discoveries were received with much coolness, both by Catholic leaders of opinion in France and Belgium, and by Protestant leaders in England and Holland. Schmerling himself appears to have been overawed, and gave forth a sort of apologetic theory, half scientific, half theologic, vainly hoping to satisfy the clerical side.

Nor was it much better in England. Sir Charles Lyell, so devoted a servant of prehistoric research thirty years later, was still holding out against it on the scientific side; and, as to the theological side, it was the period when that great churchman, Dean Cockburn, was insulting geologists from the pulpit of York Minster, and the Rev. Mellor Brown denouncing geology as "a black art," "a forbidden province"; and when in America Prof. Moses Stuart and others like him were belittling the work of Benjamin Silliman and Edward Hitchcock.

In 1840 Godwin Austin presented to the Royal Geological So-

ciety an account of his discoveries in Kent's Cavern near Torquay, and especially of human bones and implements mingled with bones of the elephant, rhinoceros, cave bear, hyena, and other extinct animals; yet this memoir, like that of McEnery fifteen years before, found an atmosphere so unfavorable that it was not published.

But just at the middle of the nineteenth century came the beginning of a new epoch in science—an epoch when all these earlier discoveries were to be interpreted by means of investigations in a different field: for, in 1847, a man previously unknown to the world at large, Boucher de Perthes, published at Paris the first volume of his work on Celtic and Antediluvian Antiquities, and in this he showed engravings of typical flint implements and weapons, of which he had discovered thousands upon thousands in the high drift beds near Abbeville in northern France.

The significance of this discovery was great indeed—far greater than Boucher himself at first supposed. The very title of his book showed that he at first regarded these implements and weapons as having belonged to men overwhelmed at the Deluge of Noah; but it was soon seen that they were something very different from proofs of the literal exactness of Genesis: for they were found in terraces at great heights above the river Somme, and, under any possible theory having regard to the truth, must have been deposited there at a time when the river system of northern France was vastly different from anything known in the historic period. The whole discovery indicated a series of great geological changes since the time when these implements were made, requiring cycles of time compared to which the space allowed by the orthodox chronologists were as nothing.

His work was the result of over ten years of research and thought. Year after year a force of men under his direction had dug into these high-terraced gravel deposits of the river Somme, and in his book he now gave, in the first full form, the results of his labor. So far as France was concerned, he was met at first by what he calls "a conspiracy of silence," and by a contemptuous opposition among orthodox scientists, at the head of whom stood Élie de Beaumont.

This heavy, sluggish opposition seemed immovable: nothing that Boucher could do or say appeared to lighten the pressure of the orthodox theological opinion behind it—not even his belief that these fossils were remains of men drowned at the Deluge of Noah, and that they were proofs of the literal exactness of Genesis seemed to help the matter. His opponents felt instinctively that such discoveries boded danger to the accepted view, and they were right: Boucher himself soon saw the folly of trying to account for them by the orthodox theory which he had adopted at first.

And it must be confessed that not a little force was added to the opposition by certain characteristics of Boucher de Perthes himself; gifted, foresighted, and vigorous as he was, he was his own worst enemy; carried away by his own discoveries, he jumped to the most astounding conclusions: the engravings in the later volume of his great work, showing what he thought to be human features and inscriptions upon some of the flint implements, are worthy of a comic almanac; and at the great National Museum of Archæology at St. Germain, beneath the shelves bearing the remains which he discovered, which mark the triumph of a great new movement in human science, are drawers containing specimens hardly worthy of a penny museum, from which he drew the most unwarranted inferences as to the language, religion, and usages of prehistoric man.

But Boucher triumphed none the less. Among his bitter opponents at first was Dr. Rigollot, who in 1855, searching earnestly for materials to refute the innovator, dug into the deposits of St. Acheul —and was converted: for he found implements similar to those of Abbeville, making still more certain the existence of man during the Drift period. So, too, Gaudry a year later made similar discoveries.

But most important was the evidence of the truth which now came from other parts of France and from many other countries. The French leaders in geological science had been held back, not only by awe of Cuvier, but by recollections of Scheuchzer. Ridicule has always been a serious weapon in France, and the ridicule which finally overtook the adherents of the attempt of Scheuchzer, Mazurier, and others, to square geology with Genesis, was still remembered. From the great body of French scientists, therefore, Boucher secured at first no aid. His support came from the other side of the Channel. The most eminent English geologists, such as Falconer, Prestwich, and Lyell, visited the beds at Abbeville and St. Acheul, convinced themselves that the discoveries of Boucher, Rigollot, and their colleagues were real, and then quietly but firmly told England the truth.

And now there appeared a most effective ally in France. The arguments used against Boucher de Perthes and some of the other early investigators of bone caves had been that the implements found might have been washed about and turned over by great floods, and therefore that they might be of a recent period; but in 1861 Edward Lartet published an account of his own excavations at the Grotto of Aurignac, and the proof that man had existed in the time of the Quaternary animals was complete. This grotto had been carefully sealed in prehistoric times by a stone at its entrance; no interference from disturbing currents of water had been possible; and Lartet found, in place, bones of eight out

of nine of the main species of animals which characterize the Quaternary period in Europe; upon them were marks of cutting implements, and in the midst of them coals and ashes.

Close upon these came the excavations at Eyzies by Lartet and his English colleague, Christy. In both these men there was a sobriety and a carefulness in making researches and in stating results which converted many of those who had been repelled by the enthusiasm of Boucher de Perthes. The two colleagues found buried together, in the stony deposits made by the water dropping from the roof of the cave at Eyzies, the bones of numerous animals extinct or departed to arctic regions, one of these a vertebra of a reindeer with a flint lance-head still fast in it, and with these were found evidences of fire.

Discoveries like these were thoroughly convincing. But there still remained here and there a few gainsayers in the supposed interest of Scripture, and these, in spite of the convincing array of facts, insisted that in some way, by some combination of circumstances, these bones of extinct animals of vastly remote periods might have been brought into connection with all these human bones and implements of human make in all these different places, without supposing that these ancient relics of men and animals were of the same period. But a new class of discoveries came to silence this contention. At La Madeleine in France, and at various other places, were found rude but striking carvings and engravings on bone and stone representing sundry specimens of those long-vanished species. These specimens, or casts of them, can now be seen in all the principal museums. They show the hairy mammoth, the cave bear, and various other animals of the Quaternary period, carved rudely but vigorously by contemporary men; and, to complete the significance of these discoveries, travelers returning from the icy regions of North America have brought similar carvings of animals now existing in those regions, made by the Eskimos during their long arctic winters to-day.*

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* For the explorations in Belgium, see Dupont, Le Temps Préhistorique en Belgique. For the discoveries by McEnery and Godwin Austin, see Lubbock, Prehistoric Times, London, 1869, chap. x; also Cartailhac, Joly, and others above cited. For Boucher de Perthes, see his Antiquités Celtiques et Antédiluviennes, Paris, 1847–'64, vol. iii, pp. 526 *et seq.* For sundry extravagances of Boucher de Perthes, see Reinach, Description Raisonnée du Musée de St. Germain en Laye, Paris, 1889, vol. i, pp. 16 *et seq.* For the mixture of sound and absurd results in Boucher's work, see Cartailhac as above, p. 19. Boucher had published in 1838 a work entitled De la Création, but it seems to have dropped dead from the press. For the attempts of Scheuchzer to reconcile geology and Genesis by means of the *Homo diluvii testis*, and similar "diluvian fossils," see the chapter on Geology in this series. The original specimens of those prehistoric engravings upon bone and stone may be best seen at the Archæological Museum of St. Germain and the British Museum. For engravings of some of the most recent, see especially Dawkins's Early Man in Britain, chap. vii, and the Catalogue du Musée du St. Germain. For comparison of this prehistoric work with that

As a result of these discoveries and others like them, showing that man was not only a contemporary with long-extinct animals of past geological epochs, but that he had already developed into a stage of culture above pure savagery, the tide of thought began to turn. Especially was this seen in 1863, when Lyell published the first edition of his Geological Evidence of the Antiquity of Man; and the fact that he had so long opposed the new ideas gave force to the clear and conclusive argument which led him to renounce his early scientific beliefs.

Research among the evidences of man's existence in the early Quaternary, and possibly in the Tertiary period, was now pressed forward along the whole line. In 1864 Gabriel Mortillet founded his review devoted to this subject; and in 1865 the first of a series of scientific congresses devoted to such researches was held in Italy. These investigations went on vigorously in all parts of France and spread rapidly to other countries. The explorations which Dupont began in 1864, in the caves of Belgium, gave to the museum at Brussels eighty thousand flint implements, forty thousand bones of animals of the Quaternary period, with a number of human skulls and bones found mingled with these remains. From Germany, Italy, Spain, America, India, and Egypt similar results were reported.

Especially noteworthy were the further explorations of the caves and drift throughout the British Islands. The discovery by Colonel Wood in 1861, of flint tools in the same strata with bones of the earlier forms of the rhinoceros, was but typical of many. A thorough examination of the caverns of Brixham and Torquay, by Pengelly and others, made it still more evident that man had existed in the early Quaternary period: the existence of a period before the Glacial epoch or between different glacial epochs in England, when the Englishman was a savage, using rude stone tools, was then fully ascertained, and, what was more significant, there were clearly shown a gradation and evolution even in the history of that period. It was found that this ancient Stone epoch showed progress and development: in the upper layers of the caves, with remains of the reindeer, who, although he has migrated from these regions, still exists in more northern climates, were found stone implements revealing some little advance in civilization; next below these, sealed up in the stalagmite, came, as a rule, another layer, in which the remains of reindeer were rare and those of the mammoth more frequent, the implements found in this stratum being less skillfully made than

produced to-day by the Eskimos and others, see Lubbock, Prehistoric Times, chapters x and xiv. For very striking exhibitions of this same artistic gift in a higher field to-day by descendants of the barbarian tribes of northern America, see the very remarkable illustrations in Rink, Danish Greenland, London, 1877, especially those in chap. xiv.

those in the upper and more recent layers; and, finally, in the lowest levels, near the floors of these ancient caverns, with remains of the cave bear and others of the most ancient extinct animals, were found stone implements evidently of a yet ruder and earlier stage of human progress. No fairly unprejudiced man can visit the cave and museum at Torquay without being convinced that there were a gradation and evolution in these beginnings of human civilization. The evidence is complete; the masses of breccia taken from the cave, with the various soils, implements, and bones carefully kept in place, put this progress beyond a doubt.

All this indicated a great antiquity for the human race; but in it lay the germs of still another great truth, even more important and more serious in its consequences to the older theologic view, and this will be discussed in the following chapter.

But new evidences came in, showing a yet greater antiquity of man. Remains of animals were found in connection with human remains, which showed not only that man was living in times more remote than the earlier of the new investigators had dared dream, but that some of these early periods of his existence must have been of immense length, embracing climatic changes betokening different geological periods: for with remains of fire and human implements and human bones were found not only bones of the hairy mammoth and cave bear, woolly rhinoceros and reindeer, which could only have been deposited there in a time of arctic cold, but bones of the hyena, hippopotamus, saber-toothed tiger, and the like, which could only have been deposited when there was in these regions a torrid climate. The conjunction of these remains clearly showed that man had lived in England early enough and long enough to pass through times when there was arctic cold and times when there was torrid heat; times when great glaciers stretched far down into England and indeed into the continent, and times when England had a land connection with the European continent, and the European continent with Africa, allowing tropical animals to migrate freely from Africa to the middle regions of England.

The question of the origin of man at a period vastly earlier than the sacred chronologists permitted was thus absolutely settled; but among the questions regarding the existence of man at a period yet more remote, the Drift period, there was one which for a time seemed to give the champions of science some difficulty. The orthodox leaders in the time of Boucher de Perthes, and for a considerable time afterward, had a weapon of which they made good use; the statement that no human bones had yet been discovered in the drift. The supporters of science

naturally answered that few if any other bones as small as those of man had been found, and that this fact was an additional proof of the great length of the period since man had lived with the extinct animals; for, since specimens of human workmanship proved man's existence as fully as remains of his bones could do, the absence or even rarity of human and other small bones simply indicated the long periods of time required for dissolving them away.

Yet Boucher, inspired by the genius he had already shown, and filled with the spirit of prophecy, declared that human bones would yet be found in the midst of the flint implements, and in 1863 he claimed that this prophecy had been fulfilled by the discovery at Moulin Quignon of a portion of a human jaw deep in the early Quaternary deposits. But his triumph was short-lived; the opposition ridiculed his discovery; they showed that he had offered a premium to his workmen for the discovery of human remains, and they naturally drew the inference that some tricky laborer had deceived him. The result of this was, that the men of science felt obliged to acknowledge that the Moulin Quignon discovery was not proved.

But ere long human bones were found in the deposits of the early Quaternary period, or indeed of an earlier period, in various other parts of the world, and the question regarding the Moulin Quignon relic was of little importance.

We have seen that researches regarding the existence of prehistoric man in England and on the Continent were at first mainly made in the caverns; but the existence of man in the earliest Quaternary period was confirmed on both sides the English Channel, in a way even more striking, by the close examination of the drift and early gravel deposits. The results arrived at by Boucher de Perthes were amply confirmed in England. Rude stone implements were found in terraces a hundred feet and more above the levels at which various rivers of Great Britain now flow, and under circumstances which show that, at the time when they were deposited, the rivers of Great Britain in many cases were entirely different from those of the present period, and formed parts of the river system of the European continent. Researches in the high terraces above the Thames, the Ouse, as well as at other points in Great Britain, placed beyond a doubt the fact that man existed on the British Islands at a time when they were connected by solid land with the Continent, and made it clear that, within the period of the existence of man in northern Europe, a large portion of the British Islands had been sunk to depths between fifteen hundred and twenty-five hundred feet beneath the Northern Ocean—had risen again from the water—had formed part of the continent of Europe, and had been in

unbroken connection with Africa, so that elephants, bears, tigers, lions, the rhinoceros and hippopotamus, of species now mainly extinct, had left their bones in the same deposits with human implements as far north as Yorkshire. Moreover, connected with this fact came in the new conviction, forced upon geologists by the more careful examination of the earth and its changes, that such elevations and depressions of Great Britain and other parts of the world were not the results of sudden cataclysms, but of slow processes extending through vast cycles of years—processes such as are now known to be going on in various parts of the world. Thus it was that the six or seven thousand years allowed by even the most liberal theologians of former times were seen more and more clearly to be but as a mere nothing in the long succession of ages since the appearance of man.

Confirmation of these results came from various other parts of the world, especially from the drift deposits both on the eastern and western coasts of America. The discoveries at Trenton, New Jersey, and at various places in Delaware, Ohio, Minnesota, and elsewhere, along the southern edge of the drift of the glacial epochs, clinched the new scientific truth yet more firmly; and the statement made by an eminent American authority is, that "man was on this continent when the climate and ice of Greenland extended to the mouth of New York Harbor." The discoveries of prehistoric remains on the Pacific coast, and especially in British Columbia, finished completely the last chance at a reasonable contention by the adherents of the older view. As to these investigations on the Pacific slope of the United States, the discoveries of Whitney and others in California had been so made and announced that the judgment of scientific men regarding them was suspended until the visit of perhaps the greatest living authority in his department, Alfred Russel Wallace, in 1887. He confirmed the view of Prof. Whitney and others with the statement that "both the actual remains and works of man found deep under the lava-flows of Pliocene age show that he existed in the New World at least as early as in the Old." To this may be added the discoveries in British Columbia, which prove that, since man existed in these regions, "valleys have been filled up by drift from the waste of mountains to a depth in some cases of fifteen hundred feet; this covered by a succession of tuffs, ashes, and lava-streams from volcanoes long since extinct, and finally cut down by the present rivers through beds of solid basalt, and through this accumulation of lavas and gravels." The immense antiquity of the human remains in the gravels of the Pacific coast is summed up by a most eminent English authority and declared to be proved, "first, by the present river systems being of subsequent date, sometimes cutting through them and their superin-

cumbent lava-cap to a depth of two thousand feet; secondly, by the great denudation that has taken place since they were deposited, for they sometimes lie on the summits of mountains six thousand feet high; thirdly, by the fact that the Sierra Nevada has been partly elevated since their formation." *

As an important supplement to these discoveries of ancient implements came sundry comparisons made by eminent physiolo-

* For the general subject of investigations in British prehistoric remains, see especially Boyd Dawkins, Early Man in Britain and his Place in the Tertiary Period, London, 1880. For Boucher de Perthes's account of his discovery of the human jaw at Moulin Quignon, see his Antiquités Celtiques et Antédiluviennes, vol. iii, pp. 542 *et seq.*, Appendix. For an excellent account of special investigations in the high terraces above the Thames, see J. Allen Brown, F. G. S., Palæolithic Man in Northwest Middlesex, London, 1887. For discoveries in America, and the citation regarding them, see Wright, The Ice Age in North America, New York, 1889, chap. xxi. Very remarkable examples of these specimens from the drift at Trenton may be seen in Prof. Abbott's collections at the University of Pennsylvania. For an admirable statement, see Prof. Henry W. Haynes, in Wright, as above. For proofs of the vast antiquity of man upon the Pacific coast, cited in the text, see Skertchley, F. G. S., in the Journal of the Anthropological Institute for 1887, p. 336; see also Wallace, Darwinism, London, 1890, chap. xv; and for a summary, as cited, Laing, Problems of the Future, London, 1889. For a striking summary of the evidence that man lived before the last submergence of Britain, see Brown, Palæolithic Man in Northwest Middlesex, as above cited. For proofs that man existed in a period when the streams were flowing hundreds of feet above their present level, see ibid., p. 33. As to the evidence of the action of the sea and of glacial action in the Welsh bone caves after the remains of extinct animals and weapons of human workmanship had been deposited, see ibid., p. 198. For a good statement of the slowness of the submergence and emergence of Great Britain, with an illustration from the rising of the shore of Finland, see ibid., pp. 47, 48. As to the flint implements of Palæolithic man in the high-terraced gravels throughout the Thames Valley, associated with bones of the mammoth, woolly rhinoceros, etc., see Brown, p. 31. For still more conclusive proofs that man inhabited North Wales before the last submergence of the greater part of the British Islands to a depth of twelve hundred to fourteen hundred feet, see ibid., pp. 199, 200. For maps showing the connection of the British river system with that of the Continent, see Boyd Dawkins, Early Man in Britain, London, 1880, pp. 18, 41, 73; also, Lyell, Antiquity of Man, chap. xiv. As to the long continuance of the early Stone period, see James Geikie, The Great Ice Age, New York, 1888, p. 402. As to the impossibility of the animals of arctic and torrid regions living together or visiting the same place at different times in the same year, see Geikie, as above, pp. 421 *et seq.*; and for a conclusive argument that the animals of the period assigned lived in England, not since, but before, the Glacial period, or in the interglacial period, see ibid., p. 469. For a very candid statement by perhaps the foremost leader of the theological rear-guard, admitting the insuperable difficulties presented by the Old Testament chronology as regards the creation and the deluge, see the Duke of Argyll's Primeval Man, pp. 90–100, and especially pp. 93, 124. For a succinct statement on the general subject, see Laing, Problems of the Future, London, 1889, chapters v and vi. For discoveries of prehistoric implements in India, see notes by Bruce Foote, F. G. S., in the British Journal of the Anthropological Institute for 1886 and 1887. For similar discoveries in South Africa, see Gooch, in Journal of the Anthropological Institute of Great Britain and Ireland, vol. xi, pp. 124 *et seq.* For proofs of the existence of Palæolithic man in Egypt, see Mook, Haynes, Pitt-Rivers, and others, cited at length in the next chapter. For the corroborative and concurrent testimony of ethnology, philology, and history to the vast antiquity of man, see Tylor, Anthropology, chap. i.

gists between human skulls and bones found in different places and under circumstances showing vast antiquity.

Human bones had been found under these circumstances as early as 1835 at Canstadt near Stuttgart, and in 1856 in the Neanderthal near Düsseldorf; but in more recent searches they have been discovered in a multitude of places, especially in Germany, France, Belgium, England, the Caucasus, Africa, and North and South America. But comparison of these bones showed that even in that remote Quaternary period there were great differences of race, and here again came in an argument for the yet earlier existence of man on the earth; for long previous periods must have been required to develop such racial differences. Considerations of this kind have given a new impulse to the belief that man's existence dates back at least into the Tertiary period. The evidence for this earlier origin of man has been ably summed up not only by its brilliant advocate, Mortillet, but by a former opponent, one of the most conservative of modern anthropologists, Quatrefages; and the conclusion arrived at by both is, that man did really exist in the Tertiary period. The acceptance of this conclusion is also seen in the recent work of that most able investigator, Alfred Russel Wallace, who, cautious and conservative as he is, places the origin of man not only in the Tertiary period, but in an earlier stage of it than most have dared assign; even in the Miocene.

The first thing raising a strong presumption, if not giving proof, that man existed in the Tertiary, was the fact that from all explored parts of the world came in more and more evidence that in the earlier Quaternary man existed in different, strongly marked races and in great numbers. From all regions which geologists had explored, even from those the most distant and different from each other, came this same evidence—from northern Europe to southern Africa; from France to China; from New Jersey to British Columbia; from British Columbia to Peru. The development of man in such numbers and in so many different regions, with such differences of race and at so early a period, must have required a long previous time.

This argument seemed to be strengthened by discoveries of bones bearing marks apparently made by cutting instruments, in the Tertiary formations of France and Italy, and by the discoveries of what were claimed to be flint implements by the Abbé Bourgeois in France, and of implements and human bones by Prof. Capellini in Italy.

On the other hand, some of the more cautious men of science are content to say that the existence of man in the Tertiary period is not yet settled. As to his existence throughout the Quaternary epoch no new proofs are needed. Even so determined a supporter

of the theological side as the Duke of Argyll has been forced to yield to the evidence.

Of attempts to make an exact chronological statement throwing light on the length of the various prehistoric periods, the most notable have been those by M. Morlot, on the accumulated strata of the Lake of Geneva; by Gilliéron, on the silt of Lake Neufchâtel; by Horner, in the delta deposits of Egypt; and by Riddle, in the delta of the Mississippi. But while these have failed to give anything like an exact result, all these investigations together point to the one great truth so amply established, of the vast antiquity of man, and the utter inadequacy of the orthodox chronology based by theologians upon our sacred books. The period of man's past life upon our planet, which has been fixed by the universal Church, "always, everywhere, and by all," is thus perfectly proved to be merely trivial compared with those vast geological epochs during which man is now known to have existed.*

GREENLAND AND THE GREENLANDERS.†

By ELISÉE RECLUS.

TILL recently Hooker, Payer, and others supposed that the interior of Greenland presented vast spaces free of ice, grassy valleys where herds of reindeer grazed, and popular legends were appealed to in support of this view. Nordenskjöld also suggested that the phenomenon might be explained by the action of the winds, which after crossing the inland ranges descended in warm currents like the *föhn* of Switzerland, and thus melted the snows of the valleys. But the systematic researches made in recent years have failed to discover any of these inland oases. The whole land appears, on the contrary, to be covered with a continuous ice-cap fringed by glaciers which move down the outer valleys to the neighborhood of the sea, or to the fiords of the periphery. The valleys themselves have disappeared, and, despite local irregu-

* As to the evidence of man in the Tertiary period, see works already cited, especially Quatrefages, Cartailhac, and Mortillet. For a summary, see Laing, as above, pp. 103–105. See also, for a summing up of the evidence in favor of man in the Tertiary period, Quatrefages, Histoire Général des Races humaines, in the Bibliothèque Étymologique, Paris, 1887, chap. iv. As to the earlier view, see Vogt, Lectures on Man, London, 1864, lecture xi. For a thorough and convincing refutation of Sir J. W. Dawson's attempt to make the old and new Stone periods coincide, see H. W. Haynes, in chap. vi of the History of America, edited by Justin Winsor. For development of various important points in the relation of anthropology to the human occupancy of our planet, see Topinard, Anthropology, London, 1890, chap. ix.

† From advance sheets of North America, by Elisée Reclus, soon to be published by D. Appleton & Co., being the fifteenth volume of The Earth and its Inhabitants.

larities, the ice-cap slopes like a shield uniformly toward the interior. Thus, in certain places the explorer should expect to meet elevations of seven thousand or eight thousand feet; but, owing to an optical illusion, he scarcely knows whether he is climbing or descending. The horizon seems to rise on all sides, says Nordenskjöld, "as if he were at the bottom of a basin."

The aspect of these boundless wastes rolling away in scarcely perceptible undulations, and in the distance mingling the gray of their snows with the gray of the skies, at first gave the impression that Greenland was a uniform plateau, a sort of horizontal table. The belief now prevails that the rocky surface of the land is, on the contrary, carved into mountains and hills, valleys and gorges, but that the plastic snows and ice have gradually filled up all the cavities, which now show only in slight sinuosities on the surface. Allowing to the whole mass of the ice-cap an average thickness of five hundred feet, it would represent a total volume of about one hundred and fifty thousand cubic miles. This *sermer suak*, or "great ice" of the Greenlanders, flows like asphalt or tar with extreme slowness seaward, while the surface is gradually leveled by the snow falling during the course of ages and distributed by the winds. In the interior of the country the surface of the ice and snow is as smooth as if it were polished, looking like "the undisturbed surface of a frozen ocean, the long but not high billows of which rolling from east to west are not easily distinguishable to the eye."* Nevertheless, the exterior form of the ice-cap has been greatly diversified, at least on its outer edge, where in many places it is difficult to cross, or even quite impassable. The action of lateral pressure, of heat produced by the tremendous friction, of evaporation and filtration, has often broken the surface into innumerable cones a few yards high, in form and color resembling the tents of an encampment. The depressions of the snowy plateau are filled with meres, lagoons, and lakes; streams and rivulets excavate winding gorges with crystal walls in the snow and ice. Cascades, frozen at night, plunge during the day into profound crevasses; during the expedition of 1870 Nordenskjöld saw intermittent jets of water rising to a great height, which he was unable to study, but which he supposes must be geysers.

Most of the glaciers reaching the coast round the Greenland seaboard present a somewhat regular frontal line, from which blocks of varying size break off with every wave and drift away with the current. But the frozen streams which yield those huge masses large enough to be called icebergs, that is, "mountains of ice," are relatively few in number, their production requiring a combination of favorable circumstances, such as the thickness of

* Nansen, Proceedings of the Royal Geographical Society, August, 1889.

the parent glacier, the form of its bed, and the depth of the water at its mouth. The larger fragments originate for the most part along that remarkable break which is presented in the normal formation of the coast-line between Egedesminde and the Svartenhuk Peninsula. Rink enumerates not more than thirty Greenland glaciers which discharge really large icebergs, and of this number only six or eight yield blocks of the first magnitude.

The average velocity of the congealed masses is about fifty feet in the twenty-four hours, but in some places a much greater speed has been recorded, though still varying considerably with the seasons. A branch of the Augpadlartok glacier, north of Upernavik, moves at the rate of one hundred feet a day, the highest yet measured. But how enormous must be the pressure of the inland ice-fields to discharge into the sea the vast quantities of icebergs which are yearly sent adrift along the Greenland seaboard! Estimated in a single block the annual discharge from each of the five best-known glaciers would represent a mass of about seventeen billion cubic feet in capacity, and fifty-six hundred feet in height, depth, and thickness. Reduced to a liquid state this mass would be equivalent to a stream discharging seaward five hundred cubic feet per second, or 15,500,000 a year.

The formation of this drift ice, or floating icebergs, is one of those phenomena which were discussed long before the seaboard had been studied, or before the breaking away of the frozen masses had actually been witnessed. Wherever the glaciers discharge through a broad valley preserving a uniform width and depth for a considerable space, and advancing seaward through a fiord of like dimensions, and with gently sloping bed, the ice may progress without any of those accidents caused by the inequalities of more rugged channels. Under such conditions the compact mass glides smoothly forward over its rocky bed without developing any rents or fissures. But as it moves down like a ship on its keel, it tends to rise, being at least one twentieth lighter than the displaced water. It is also left without support by the sudden fall of its bed beyond the normal coast-line. Nevertheless, it still continues its onward movement through the waters to a point where its weight prevails over its force of cohesion with the frozen stream thrusting it forward. At this point it snaps off suddenly with a tremendous crash, and the iceberg, enveloped in a thousand fragments projected into space, plunges into the abyss and whirls round and round to find its center of gravity amid the troubled waters. On recovering from the bewilderment caused by all this tumult and chaos, the spectator finds that the glacier has apparently receded a long way toward the head of the bay, in the middle of which a crystal peak is seen slowly drifting away with the current. In this he recognizes the huge fragment detached

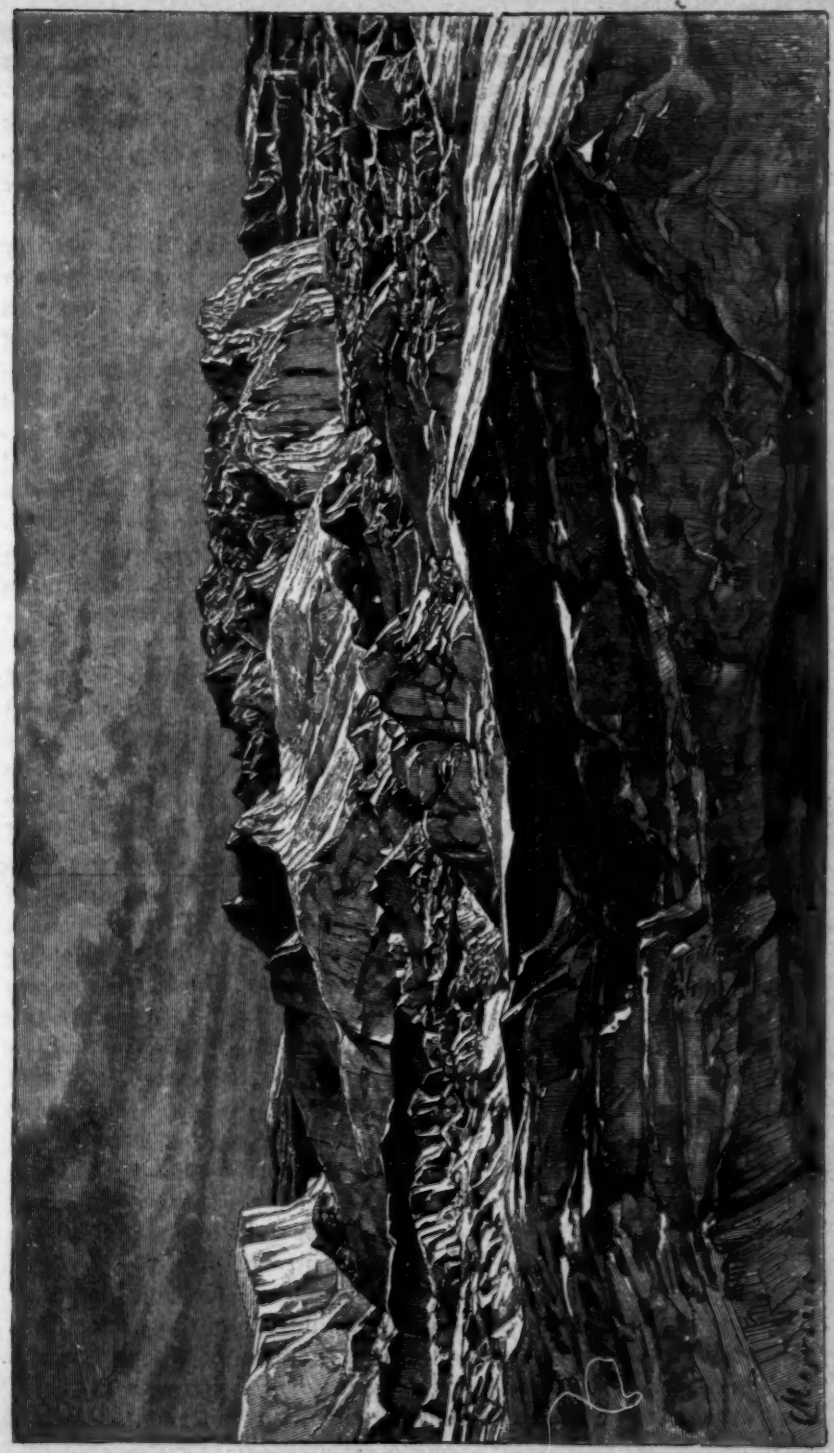


FIG. 1.—VIEW OF THE GLACIER OF SERMITSIALIK, NEAR IVIGTUT.

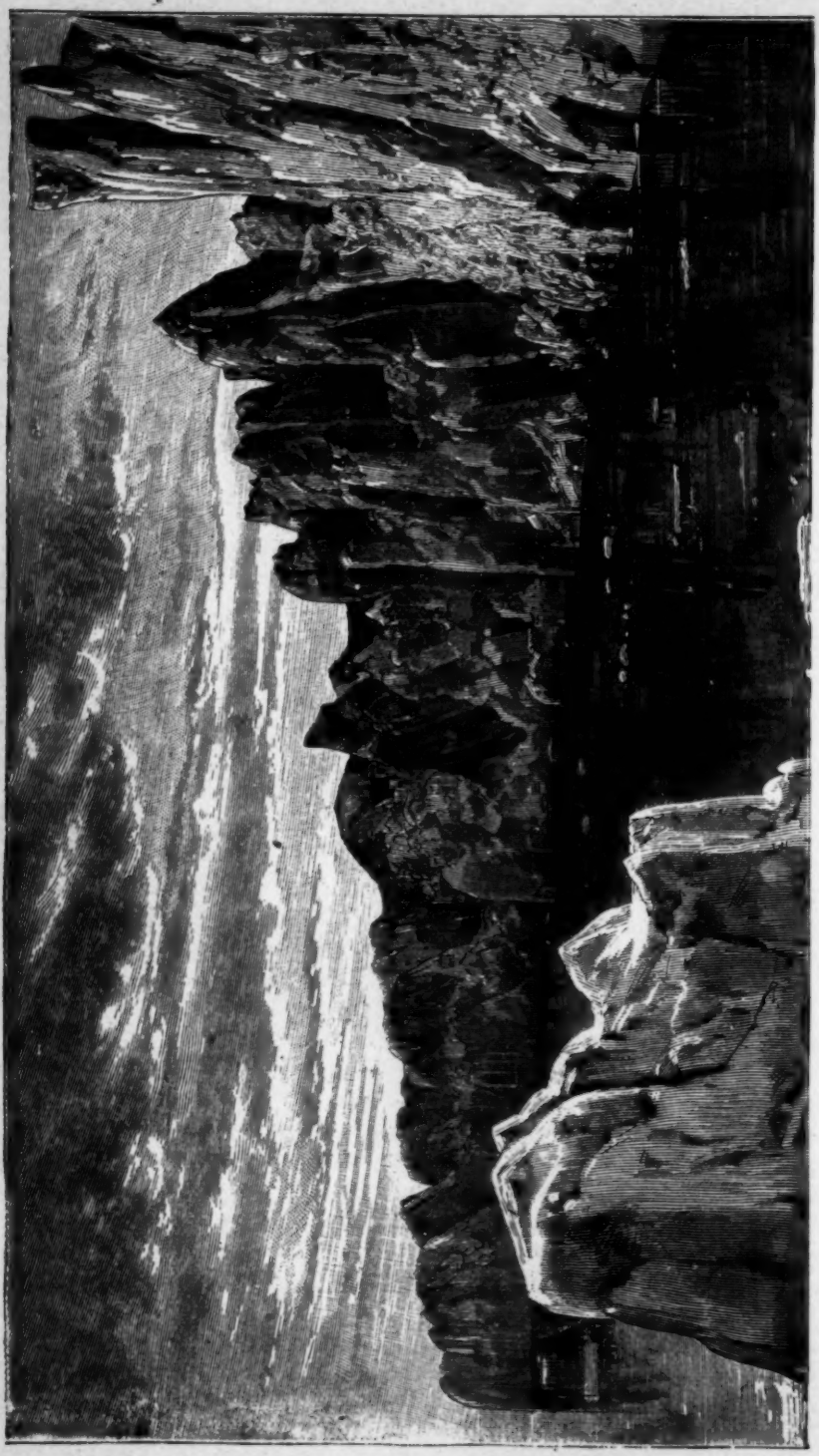
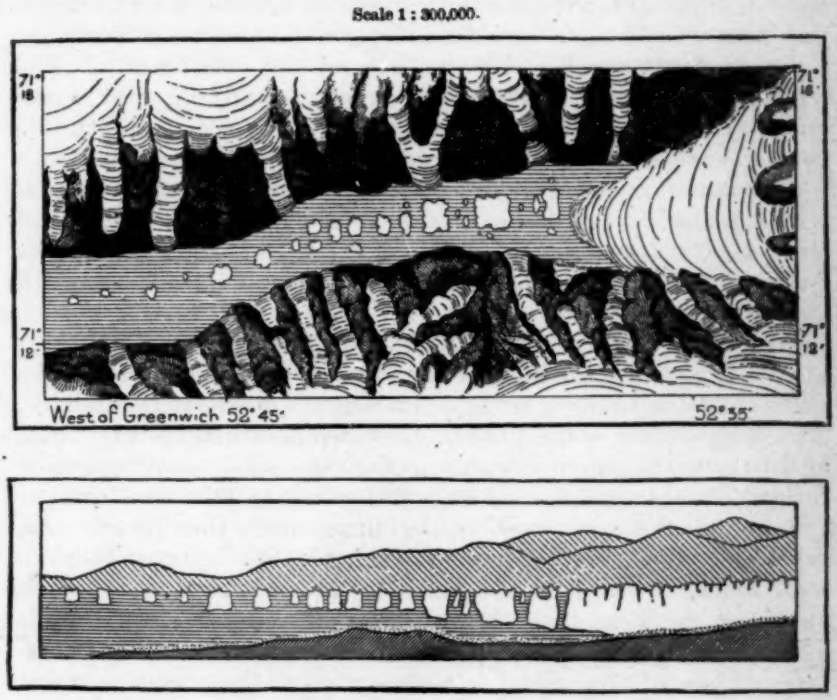


FIG. 2.—FRONT OF THE GLACIER OF SERMITSIALIK.

from the glacier, though seldom able to detect its primitive form, the greater part, say at least six sevenths of its volume, sinking below the surface.

If Greenland, like other regions, passed through a glacial epoch, the fossil remains preserved in its sedimentary rocks show that it had also its hot and temperate periods. The old formations



The scale of heights is 50 times greater than that of lengths.

FIG. 3.—MOVEMENT OF THE KANDERDLUG-SUAK GLACIER, UMANAK DISTRICT.

which have yielded Carboniferous, Triassic, and Jurassic fossils, present types of organisms comparable to those at present found in the torrid zone. The upper chalk beds, abounding in vegetable forms, analogous to those of the subtropical and temperate zones, had already been examined by Giesecke at the beginning of this century. They supplied to Nordenskjöld a very remarkable flora, especially rich in dicotyledonous plants represented by numerous families of *Cycadea*, a tree-fern, and even a bread-fruit tree. At that time the mean temperature must have been as high as 68° Fahr.

The Miocene flora, whose general physiognomy corresponds to a more temperate climate, averaging about 53° or 54° Fahr., is illustrated by splendid specimens discovered chiefly in Disco Island

and the surrounding peninsulas. Quite a fossil forest is buried under the ferruginous mass of Mount Atanekerdluk, a peak which rises to a height of over a thousand feet over against Disco, and which is now surrounded by glaciers on all sides. From these deposits Whymper, Nordenskjöld, and others have extracted one hundred and sixty-nine species of plants, of which about three fourths were shrubs and trees, some with stems as thick as a man's body. Altogether there have been discovered in the Greenland strata as many as six hundred and thirteen species of fossil plants. The most prevalent tree is a *Sequoia*, closely resembling the Oregon and Californian giants of the present epoch. Associated with this conifer were beeches, oaks, evergreen oaks, elms, hazel-nuts, walnuts, magnolias, and laurels; and these forest trees were festooned with the vine, ivy, and other creepers. A leaf of a *Cycadea* found among these fossil remains is the largest ever seen; and a true palm, the *Flabellaria*, has been discovered among the remains of these old arctic forests.

To develop such a flora the climate of north Greenland must at that time have been analogous to that at present enjoyed on the shores of Lake Geneva, twenty-four degrees nearer to the equator. According to the same gradation of temperature, the dry lands about the north pole itself must at the same epoch have had their forests of aspens and conifers. According to Oswald Heer, the change that has taken place in the climate since then represents a fall of 30° or 40° Fahr. for north Greenland. The interval between these two ages was marked by the Glacial period, whose traces are visible on the west coast.

Although incomparably poorer than that of Miocene times, the present flora of Greenland is sufficient to clothe extensive tracts with a mantle of mosses, grasses, and brushwood. Wherever the snows melt under the influence of the sun or of the warm east winds, herbaceous and other lowly plants spring up even on the exposed *nunatakker*, and to a height of five thousand feet. Owing to the uniform intensity of the solar heat, the summer flora is almost identical on the low-lying coast-lands and highest mountain-tops. True trees occur in the southern districts, where Egede was said to have measured some nearly twenty feet high. But the largest met by Rink during all his long rambles was a white birch fourteen feet high growing amid the rocks near a Norse ruin. Few trees, in fact, exceed five or six feet, while most of the shrubs become trailing plants. Such are the service and alder, which on the coast reach 65° north latitude; the juniper, which advances to 67°; and the dwarf birch, which ranges beyond 72°.

In its general features the Greenland flora, comprising about four hundred flowering plants and several hundred species of lichens, greatly resembles that of Scandinavia. Hooker and Dr.

Robert Brown regard it as essentially the same as that of the north European highlands and lacustrine regions. Even on the west coast, facing America, this European physiognomy is said to prevail, although to a less degree than on the opposite side, which appears to be much poorer in vegetable forms. But, though limited, the American element is important, supplying to the natives numerous edible berries, algæ, and fuci, which have saved whole tribes from starvation during periods of scarcity. The Europeans have also their little garden-plots, where they grow lettuce, cabbage, turnips, and occasionally potatoes about the size of schoolboys' marbles.

The great bulk of the present population consists of Danes, Danish half-breeds, and the Eskimo proper, more or less modified by crossings with the early Norse settlers. Nearly all the inhabitants, already Christianized and civilized by the missionaries, are grouped in parishes, whose organization differs from corresponding European communities only in those conditions that are imposed by the climate and the struggle for existence. There still survive, however, a few tribes of pure Eskimo stock, such as those recently discovered by European explorers beyond the Danish territory north of Melville Bay and on the east coast. Others also may perhaps exist along the shores of unvisited or inaccessible fiords. But the most northern camping-ground hitherto discovered is that of Ita (Etah), situated in Port Foulke on Smith Sound, in 78° 18′ north latitude. In 1875 and again in 1881 it was found abandoned; but it is known to have been previously inhabited, and the natives had returned to the place in 1882 and 1883.* When visited by Hall and his party, this little group of twenty persons, who had never seen any other human beings, fancied that the strangers were ghosts, the souls of their forefathers descending from the moon or rising from the depths of the abyss. In their eyes the ships of John Ross were great birds, with huge, flapping wings.

Among the Greenland Eskimo are most frequently found men of average and even high stature, especially on the east coast. Most of those on the west side are short, but thick-set and robust, with short legs, small hands, and a yellowish-white complexion. The face is broad and flat, the nose very small, the eyes brown and slightly oblique like the Chinese; the hair black, lank, and falling over the forehead; the expression mild, suggesting that of the seal, the animal which is ever in their thoughts, and whose death is their life. They have also the seal's gait and carriage, as well as a rounded figure well lined with fat to protect it from the cold. What essentially distinguishes the Eskimo from the Mongolian, with whom he was till recently affiliated, is the extremely "doli-

* Greely, Three Years of Arctic Service.

chocephalous" form of his head, the skull, with its vertical sides and sharp crest, often affecting a "scaphocephalous" or boat-like shape. According to Dall, the cranial capacity is higher than that of the red-skins.

Both sexes are dressed very much alike. European fashions, however, have already penetrated among the Greenlanders, and in many districts men are now met wearing the garb of European laborers, while the women deck themselves with cotton stuffs and many-colored ribbons. But in winter no costume could advantageously replace their capacious boots, sealskin pantaloons, close-fitting jacket, and the *amaut*, or hood which "keeps baby warm." In Danish Greenland the women no longer tattoo their chin, cheeks, hands, or feet, nor do they now insert variegated threads under the skin, the missionaries having interdicted these "pagan" practices.

FIG. 4.—GREENLAND ESKIMO.

Singing, dancing, the relation of the old legends, even athletic games among the young people, were also formerly sternly repressed. Indulgence in strong drinks is allowed only once a year, on the anniversary of the King of Denmark, and the royal monopoly of the trade with Greenland is justified on the ground that in this way the importation of spirits is prevented.

Possessing great natural intelligence combined with love of instruction, the Greenlanders may justly claim to be civilized. The great majority read and write their mother-tongue, and sing European melodies, while several speak English or Danish. Nearly all the families have their little library, and read their Eskimo newspaper, as well as the collections of national legends, illustrated with engravings by native artists. Greenland even

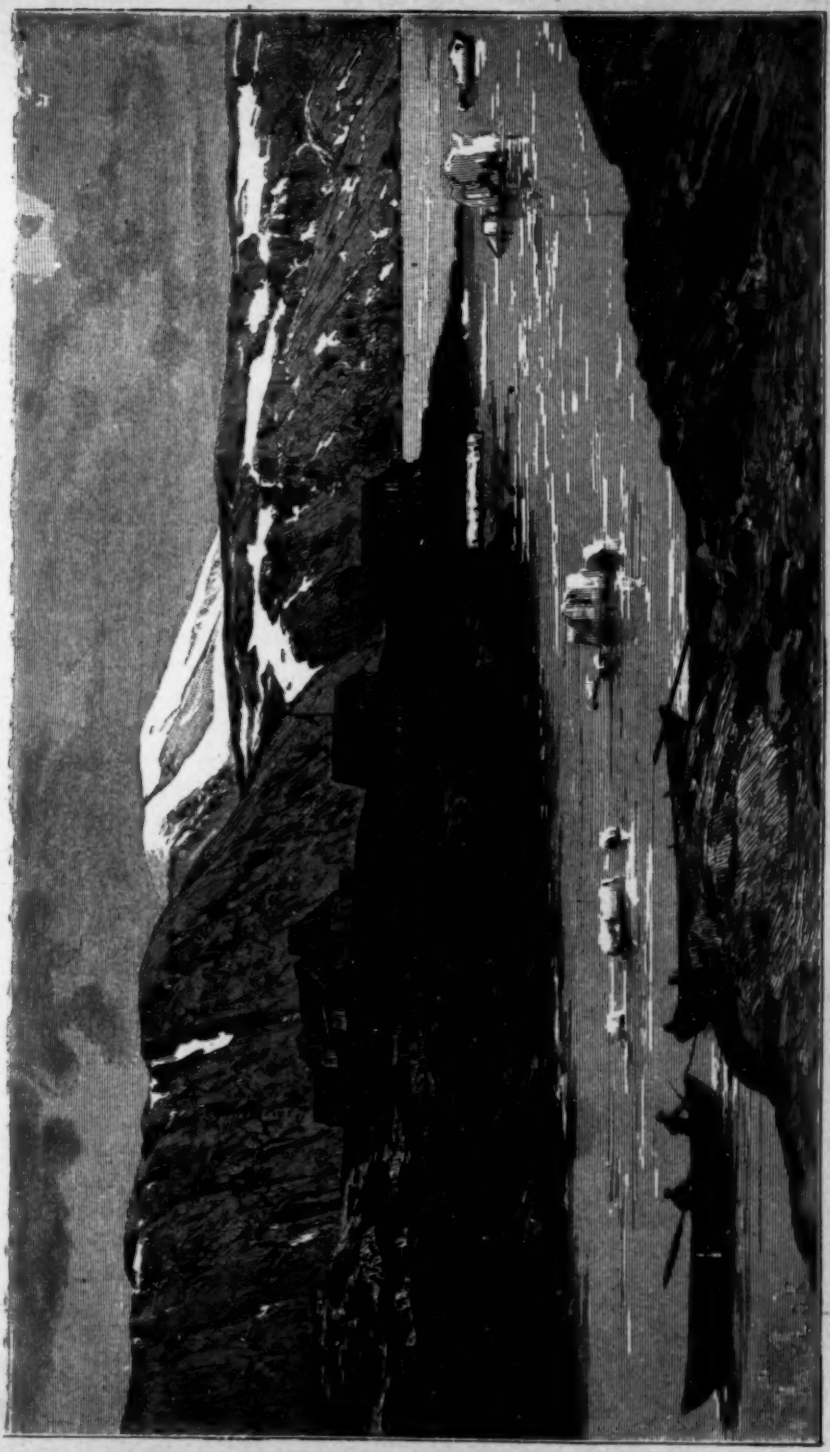


FIG. 5.—VIEW OF UPERNAVIK.

possesses at least one original work, the account of the voyages of Hans Hendrik, companion of Kane, Hall, Hayes, and Nares.

Formerly, the right of property was restricted to objects of personal use, such as clothes and weapons; the hunting-grounds belonged to the whole community, and the produce of the chase or fisheries was equally distributed among all. The rights of communal property were also regulated and safeguarded by general assemblies followed by public banquets. But the Europeans have changed all that by introducing the principle of sale and purchase, by enlarging to their own profit the rights of personal ownership, and proclaiming the new gospel of "every man for himself." The result is a general impoverishment and moral degradation of the people. They are no longer like the Eskimo visited by Graah on the east coast—"the gentlest, the most upright and virtuous of men." Nevertheless, the language possesses not a single abusive term, and it is impossible to swear in Eskimo.

The part of Greenland where Eric the Red built his stronghold, and where the banished Norsemen flocked around him, is still one of the least deserted regions, as it also is the most fertile and temperate. Julianahaab, capital of this district, contains one fourth of the entire population of the country grouped on the banks of a small stream in a grassy valley near a deep fiord, which is unfortunately not easily accessible to shipping.

Upernivik (Upernavik) and Tasiusak, lying still farther north in 73° 24′ north latitude, are the last European settlements in Greenland, gloomy abodes lost amid the snows at the foot of yellowish or brick-red rocks. In winter the sun sets for eighty days, yet by a sort of mockery this glacial district bears an Eskimo name meaning "spring." The horrors of war were extended to this extremity of the habitable world at the beginning of the present century, when Upernavik was burned by the English whalers, and all communication between Greenland and Denmark interrupted for the seven years from 1807 to 1814.

THE Siamese Government is taking great pains to encourage the speedy development of the enormous potential resources of the country, and has sagaciously done much in that direction. Telegraphs have been established; schools, hospitals, and other public buildings have been erected, and are increasing every day. A tramway company, supported mainly by Siamese capital, is running street cars in the metropolis. A river flotilla company, wholly Siamese, carries the passenger traffic of the stream on which Bangkok is built; important gold-mining operations have been begun by a company, in which a majority of the subscribers are Siamese; and a trunk line of railway is under contract. A large and lucrative export trade in cattle has sprung up; and mills, docks, and fleets of German and English ships, all doing a flourishing business, attest the prevalence of a spirit of enterprise.

EVOLUTION AND THE DISTRIBUTION OF ANIMALS.*

By DAVID STARR JORDAN,
PRESIDENT OF THE UNIVERSITY OF INDIANA.

I.

NO one with good eyes and brains behind them has ever looked forth on the varied life of the world—on forest or field or brook or sea—without at least once asking himself this question: "What is the cause of nature's endless variety?" We see many kinds of beasts and birds and trees and flowers and insects and blades of grass, yet when we look closely we find not one grass-blade in the meadow quite like another blade. Not one worm is like its fellow-worm, and not one organism in body or soul is the measure of its neighbor. You may search all day to match one clover-leaf, and, should you succeed, even then you have failed; for, if the two leaves agree in all physical respects, they may still be unlike in that which we can not see, their ancestries, their potentialities. Again, with each change of conditions, of temperature, of moisture, of space, of time, with each shifting of environment, the range in variety increases. "Dauer in Wechsel" (persistence in change); "this phrase of Goethe," says Amiel, "is a summing up of nature." And the naturalist will tell you that the real variety is far greater than that which appears. He will tell you that, where commonness seems to prevail, it is the cover of variety. The green cloak which covers the brown earth is the shelter under which millions of organisms, brown or green, carry on their life-work.

Each recognizable kind of animal or plant is known in biology as a species. The number of forms now considered as distinct species is far beyond the usual conception of those who have not made a special study of such matters. I have an old book in my library, the tenth edition of the Systema Naturæ, published by Linnæus in 1758. This book treats of all the species of animals known a little more than a century ago. In its eight hundred and twenty-three pages some four thousand different kinds of animals are named and briefly described. But for every one of these enumerated by Linnæus, more than one hundred kinds are known to the modern naturalist, and the number of species still unknown doubtless exceeds the number of those already recorded. Every year for the last quarter of a century there has been published in London a plump octavo volume known as the Zoölogical Record. Each of these volumes, larger than the whole Systema

* An address delivered before the Chicago Institute, in a course on the Testimony of Science in regard to Evolution.

Naturæ, contains the names of the species new to science added to our lists during the year of which it treats; and in the record of each year we find the names of two or three times as many as are mentioned in the whole Systema Naturæ. Yet the field shows no signs of exhaustion. As these volumes stand on the shelf together, it is easy to see that the later volumes are the thickest, and that the record for the present year is the largest of all. The additional species named and described in 1889 are more than ten thousand. Moreover, what is true of the increase of knowledge in systematic zoölogy, is even more marked in the case of botany. Such, then, is the variety of life on the globe—a variety of which Linnæus and his successors had never dared to dream.

And yet, great as this variety is, there are, after all, only a few types of structure among all animals and plants—some three or four or eight or ten general modes of development—all the rest being minor variations from these few types.

It is even true that all life is but a series of modifications of a single plan; for all organisms are composed of cells, the essential element of which is always a single substance—protoplasm. All are governed by the same laws of development, reproduction, and susceptibility to outside influences. Unity in life is therefore not less a fact than is life's great diversity. In whatever way we account for the diversity, the essential unity must not be forgotten. The bonds of unity among organisms constitute what the naturalist calls homology.

That these resemblances have some deep significance, no thoughtful student of nature has ever doubted. What this significance may be is the underlying question in that branch of philosophy which has come to be known as evolution.

In the present discussion I shall take for granted that answer to these questions which is associated with the name of Darwin; and, as a student of the relations and distribution of animals, I firmly believe that no answer to these questions fundamentally different from his will ever be possible.

The essence of the Darwinian theory is this, that the various species of the present day are all derived from pre-existing forms, more or less unlike them; that this derivation takes place through the operation of natural laws—the law of heredity, the law of response to external stimulus or environment, and the law less clearly understood by which variations from ancestral types are constantly produced; the "divine initiative" in the individual which struggles against sameness and monotony. The constant tendency of organisms to multiplication by geometric progression in a world of limited extent, already apparently full, brings about a constant struggle for existence among these organisms, and by this struggle we have the progressive adjustment of individuals

to their environment—an adjustment which is made more and more complete by the ceaseless destruction of the unadjusted. According to this theory, the same causes which have produced difference of species in the past must be still at work, and must continue to produce similar differences in the future. To the theory of derivation is opposed the old idea of "special creation." But this theory of special creation has never had in science other than a provisional existence. It was a mere name for a process not understood. If each of the millions of species of animals and plants living and extinct came about by a "special creation," then special creation can not be an operation outside the limits of law. It is simply the name given in ignorance to the law by which species are produced. What has been done so many times must be done in some uniform way. What this way is, the theory of evolution professes in some degree to define.

The fact is, the theory of development gives the only clew by which the naturalist can be guided in his work. If the mutual affinities of species do not depend on the law of heredity, they are unintelligible. They are impossible. If the variation of species is really immutability in disguise, we can not trust our senses. We are left to choose between some form of the development theory and a hopeless unscientific agnosticism, content with the surface facts, and ignorant of the laws of which these facts are the expression.

I do not wish to-night to discuss either the general question of evolution nor that special theory of the method of evolution which is associated with the name of the master of modern zoölogy. I shall take evolution and Darwinism for granted, and confine myself to a statement of certain facts and principles in the science of zoögeography and to their bearing on the question of the origin of species. There are many difficulties in bringing the facts of this science down to the needs of concrete illustration. A science so broad as to include all human history at once with the history of every group of animated organisms can not well be compressed into a discussion of a single hour. And with this I may recall the additional difficulty, present in all discussions of the subject of evolution, of distinguishing single illustrations from arguments. Isolated cases of geographical variations in species would not have great value as arguments for the development theory were the cases really isolated. The force lies in this fact, that these cases are typical; that what may be said of one is true of a thousand.

In like manner the full force of the laws of homology and heredity can only be felt when their effect is cumulative, as in the mind of the anatomist who has followed each organ through its protean disguises in a wide range of forms.

Still, again, the force of the argument drawn from embryology does not come from a knowledge of the changes in a single egg. All these studies need the second premise, obtained by years of comparison in different fields of investigation, that no case is isolated. Without this premise, the argument would be incomplete. The few cases of development or change which can be brought to popular notice are simply illustrations and not proofs.

As Prof. Bergen has well said, "it is important that we should understand that none of the kinds of evidence in favor of evolution loses so much by being represented only by scattered instances as the argument from distribution." And, conversely, no argument is so strong when all the known facts are brought into consideration together. The universal fact of the mutability of species can be really understood or appreciated only by him by whose eyes multitudes of species have been seen to change. To the ordinary observer the species seems constant, just as the face of a cliff seems constant. To the student of nature mutability is everywhere. Just as the wind and rain and frost quietly but surely change the face of a cliff, so do other forces of nature as quietly but as surely change the face of a species.

And now we may notice that it was precisely this phase of the subject, the relation of species to geography, which first attracted the attention of both Mr. Darwin and Mr. Wallace.

Both these observers noticed that island life is neither strictly like nor unlike the life of the nearest land, and that the degree of difference varies with the degree of isolation. Both were led from this fact to the theory of derivation, and to lay the greatest stress on the progressive modification resulting from the struggle for existence.

In the voyage of the Beagle, you remember, Mr. Darwin was brought in contact with the singular fauna of the Galapagos Islands, that cluster of volcanic rocks which lies in the open sea some six hundred miles west of the coast of Equador and Peru. The sea birds of these islands are essentially the same as those of the coast of Peru. So with most of the fishes. We can see how this might well be, for both sea birds and fishes can readily pass from the one region to the other. But the land birds, as well as the reptiles, insects, and plants, are mostly peculiar to the islands. The same species are found nowhere else. But other species very much like them in all respects are found, and these all live along the coast of Peru. In the Galapagos Islands, according to Darwin's notes, "there are twenty-six land birds; of these, twenty-one or perhaps twenty-three are ranked as distinct species, and would commonly be assumed to have been here created; yet the close affinity of most of these birds to American species is manifest in every character, in their habits, gestures, and tones of voice. So

it is with the other animals and with a large proportion of the plants. . . . The naturalist, looking at the inhabitants of these volcanic islands in the Pacific, feels that he is standing on American land."

The question, then, is this: If these species have been created as we find them on the Galapagos, why is it that they should all be very similar in type to other animals, living under wholly different conditions, but on a coast not so very far away? And again, why are the animals and plants of another cluster of volcanic islands—the Cape Verde Islands—similarly related to those of the neighboring coast of Africa, and wholly unlike those of the Galapagos? If the animals were created to match their conditions of life, then those of the Galapagos should be like those of Cape Verde, the two archipelagoes being extremely alike in respect to soil, climate, and physical surroundings. If the species on the islands are products of separate acts of creation, what is there in the nearness of the coasts of Africa or Peru to influence the act of creation so as to cause the island species to be, as it were, echoes of those on shore?

If, on the other hand, we should adopt the obvious suggestion that both these clusters of islands have been colonized by immigrants from the mainland, the fact of uniformity of type is accounted for, but what of the difference of species? If the change of conditions from continent to island may on the island cause such great and permanent changes as to form new species from the old, why may not like changes take place on the mainlands as well as on the islands? And if possible on the mainland of South America, what evidence have we that species are permanent anywhere? May they not be constantly changing? May not what we now consider as distinct species be only the present phase in the changing history of the series of forms which constitutes the species?

The study of these and many similar facts can lead to but one conclusion:

These volcanic islands rose from the sea destitute of land life. They were settled by the waifs of wind and of storm, birds and insects blown from the shore by trade winds, lizards carried on drift-logs and floating vegetation. Of these waifs few came perhaps in any one year, and few perhaps of those who came made the islands a home; yet, as the centuries passed on, suitable inhabitants were found. That this is not fancy we know, for we have the knowledge of many similar transfers. Every one who has approached our eastern shores by sea in the face of a storm will realize this. Hosts of land birds—sparrows, warblers, chickadees, and even woodpeckers—are carried out by the wind, a few falling exhausted on the decks of ships, a few others falling on

off-shore islands, like the Bermudas, the remainder drowned in the sea.

Of the immigrants to the Galapagos the majority doubtless die and leave no sign. A few will remain, multiply, and take possession, and their descendants are thus native to the islands. But, isolated from the great mass of their species and bred under new surroundings, these island birds come to differ from their parents and still more from the great mass of the land species of which their ancestors were members. Separated from these, their individuality would assert itself. They would assume with new environment new friends, new foes, new conditions. They would develop qualities peculiar to themselves—qualities intensified by isolation. "Migration," says Dr. Coues, "holds species true; localization lets them slip." This would be more exactly the truth should we say that localization holds peculiarities true; migration lets them slip. Local peculiarities disappear by wide association and are intensified when individuals of similar peculiarities are kept together. Should later migrations of the original land species come to the islands, the individuals surviving would in time form distinct species, or more likely, mixing with the mass of those already arrived, their special characters would be lost in those of the majority.

The Galapagos, first studied by Mr. Darwin, serve to us only as an illustration. The same problems come up in one guise or another in all questions of geographical distribution, whether of continent or island.

The relations of the fauna of different regions are intimate in direct relation to the ease by which barriers may be crossed. Distinctness is in direct proportion to isolation. What is true in this regard of the fauna of any region as a whole is likewise true of any of its individual species. The degree of resemblance among individuals is in direct proportion to the freedom of their movement, and variation within what we call specific limits is again proportionate to the barriers which prevent equal and perfect diffusion.

The various divisions or realms into which the surface of the earth may be divided on the basis of the differences in animal life each has its boundary in the obstacles offered to the spread of the average animal. Each species broadens its range as far as it can. It struggles knowingly or not to overcome the barriers of ocean or river, of mountain or plain, of woodland or desert, of moisture or drought, of cold or heat, of lack of food or abundance of enemies, whatever these barriers may be. Were it not for these barriers, every species would become what only man now is, practically cosmopolitan. Man is pre-eminently the barrier-crossing animal. The degree of hindrance offered by any barrier to the

extension of species is only relative. That which constitutes an impassable barrier to some groups is a high-road to others. The river which opposes the passage of the monkey or the cat would be the king's highway to the frog or the turtle. The waterfall which checks the ascent of the fish would be the chosen home of the ouzel.

In spite of the great variety among the barriers existing on the earth, we may divide the globe roughly into five realms or areas of distribution, having their boundaries in the sea or in differences of climate. One or two of these realms are sharply defined; the others are surrounded by a broad fringe of debatable ground, which forms a region of transition to some other zone.

The largest of these realms is the holarctic realm, which comprises nearly all of Asia, Europe, and North America, the arctic and north temperate zones. The north temperate zone has practically a continuous climate, the chief variations being in elevation and rainfall. The close union of Alaska to Siberia forms an almost unbroken land area from the eastern coast of America around to western Europe. To the south the species increase in number and variety; the arctic regions are remarkable for what they lack, yet the general character of the life is almost unbroken over this vast district. Alfred Russel Wallace refers to this unity of northern life in these words:

"When an Englishman travels by the nearest sea route from Great Britain to northern Japan, he passes by countries very unlike his own both in aspect and in natural productions. The sunny isles of the Mediterranean, the sands and date-palms of Egypt, the arid rocks of Aden, the cocoa-groves of Ceylon, the tiger-haunted jungles of Malacca and Singapore, the fertile plains and volcanic peaks of Luzon, the forest-clad mountains of Formosa, and the bare hills of China pass successively in review, until after a circuitous journey of thirteen thousand miles he finds himself at Hakodadi in Japan. He is now separated from his starting-point by an almost endless succession of plains and mountains, arid deserts or icy plateaus; yet, when he visits the interior of the country, he sees so many familiar natural objects that he can hardly help fancying he is close to his home. He finds the woods and fields tenanted by tits, hedge-sparrows, wrens, wagtails, larks, redbreasts, thrushes, buntings, and house-sparrows, some absolutely identical with our own feathered friends, others so closely resembling them that it requires a practiced ornithologist to tell the difference. . . . There are also, of course, many birds and insects which are quite new and peculiar, but these are by no means so numerous or conspicuous as to remove the general impression of a wonderful resemblance between the productions of such remote islands as Britain and Yesso" (Island Life).

A journey to the southward from Britain or Japan or Illinois, or any point within the holarctic realm, would show the successive changes in the character of life, though gradual, to be more rapid. The barrier of frost which keeps the fauna of the tropics from encroaching on the northern regions once crossed, we come on the multitude of animals whose life depends on sunshine, the characteristic forms of the neotropical realm.

The neotropical realm includes South America, the West Indies, and the hot coast-lands of Mexico and Central America. To the northward, this realm overlaps the holarctic in the transition regions of Sonora, Arizona, Texas, and Florida; but to the southward the barrier of the broad ocean keeps it practically distinct from all others. The richness of this fauna in forms and species makes the great forests of the Amazon the dream of the naturalist. Joaquin Miller gives a vivid picture of the life of tropical America:

> Birds hung and swung, green-robed and red,
> Or drooped in curved lines dreamily,
> Rainbows reversed from tree to tree,
> Or sang—low hanging overhead,
> Sang soft as if they sang and slept,
> Sang low like some far waterfall,
> And took no note of us at all.

Corresponding to the neotropical realm in position, but with a less rich and varied fauna, is the Ethiopian realm. This includes the greater part of Africa, merging gradually on the north into the holarctic realm, through the transition regions of Barbary, Italy, and Spain. In monkeys, herbivorous mammals, and reptiles, this region is wonderfully rich. In variety of birds and fishes the neotropical region far surpasses it.

The Indian realm comprises southern Asia and the neighboring islands. Its rich fauna has much in common with that of Africa, and it is, moreover, surrounded by transition districts which lead on the north to the holarctic, and on the west to the Ethiopian. On the east the Indian realm is lost in the islands of Polynesia, which represent each one its own degree of transition and isolation.

The Australian realm of Australia and its islands is more isolated than any of the others. It shows a singular development of low types of life, as though in the progress of evolution this continent had been left a whole geological age behind the others. It is certain that, could the closely competing fauna of the holarctic or Indian realms have been able to invade Australia, the dominant mammals and birds of that region would not have been marsupials and parrots. In the words of Prof. Bergen, "the antiquated forms of life are found in abundance only in regions where they

have been long shut off from communication with the great land masses." The rapid multiplication which certain holarctic animals and plants have shown when transported to the Australian realm, demonstrates what might have taken place if impassable barriers had not previously shut them out.

Each of these great realms may be indefinitely subdivided into provinces and sections, for there is no end to the possibility of analysis. No township or school district has exactly the same animals or plants as any other; and, finally, in ultimate analysis no two animals or plants are alike. Modification comes with the growth of each new individual, and steadily increases with the individual's separation in time or space from the parent stock. Moreover, we observe apparent anomalies of distribution in every realm: here appears an animal, there a plant, which seems to have a character or a place which it ought not to hold. To the result of unexpected or chance crossing of barriers these apparent anomalies in geographical distribution are due. Anomalies in distribution, like anomalies in evolution, would cease to be such if we knew all the facts and circumstances of their previous history. The present range of the tapir in Farther India and in the northern part of South America, two widely separated regions, is at first sight an anomaly of distribution. This anomaly disappears when we know that formerly the tapir ranged over the holarctic realm and became gradually extinct with the changing climate. The bones of a tapir, much like one of the South American species, are found in recent clays in Indiana (Ellettsville), and similar remains exist in France, in China, and in Burmah. The isolated, unexterminated colonies are now left at the extremes of the animal's former range, and these colonies at present constitute what we call distinct species.

The more extended are our studies the fewer are the anomalies which arrest our attention, and the fewer are the distinctive or characteristic forms. There is little foundation for the current belief that each species of animal has originated in the area it now occupies, for in many cases our knowledge of paleontology shows the reverse of this to be true. Even more incorrect is the belief that each species occupies the district or the surroundings best fitted for its habitation. This is manifest in the fact of the extraordinary fertility and persistence shown by many kinds of animals and plants in taking possession of new lands, which have become, through the voluntary or involuntary interference of man, open to their invasion. Facts of this sort are the "enormous increase of rabbits and pigs in Australia and New Zealand, of horses and cattle in South America, and of the sparrow in North America, though in none of these cases are the animals natives of the countries in which they thrive so well" (Wallace).

The persistent spreading of European weeds to the exclusion of our native plants is a fact too well known to every farmer in America. The constant movement westward of the white-weed and the Canada thistle marks the steady deterioration of our grass-fields. Especially noteworthy has been this change in Australia and New Zealand. In New Zealand the weeds of Europe, toughened by centuries of struggle, have won an easy victory over the native plants. Edward Wakefield, in his history of New Zealand, says that "many animals and birds acquire peculiarities in the new country which would indeed astonish those accustomed to them in the old. They usually run to a much larger size and breed oftener. They also take to strange kinds of food. Birds deemed granivorous at home become insectivorous here, and *vice versa*. Some learn the habits of the native species. Skylarks imitate the native wagtail, and may often be seen perching on fences and telegraph wires. They sing in the night-time, too, a thing unheard of in the old country, and doubtless acquired from the nocturnal habits of New Zealand birds."

The European house-fly in New Zealand has completely extirpated the large blue-bottle fly which was formerly a source of great annoyance to the settlers. An account is given of a farmer who filled a bottle with house-flies and carried them eighty miles into the country, liberating them one by one, in the vicinity of his sheep-folds, in order to let them take the place of the native flies.

It is said that red clover would not grow in New Zealand until bumble-bees were introduced to fertilize its flowers. Wakefield estimates that the introduction of these large wild bees has been worth five million dollars to the farmers in New Zealand.

Dr. Hooker states that, in New Zealand, "the cow-grass has taken possession of the road-sides; dock and water-cress choke the rivers, the sow-thistle is spread all over the country, growing luxuriantly up to six thousand feet; white clover in the mountain districts displaces the native grasses," and the native (Maori) saying is, "As the white man's rat has driven away the native rat, as the European fly drives away our own, and the clover kills our fern, so will the Maoris disappear before the white man himself" (E. L. Youmans).

As among some characteristic survivals of the Celts in Hampshire, England, Mr. T. W. Shore mentions the round huts of the charcoal-burners, resembling those which were common in the Celtic period; the art of osier-working or basket-making; the mounds on which many ancient churches are built, which were probably sacred sites of those people; and the peculiar orientation of many churches twenty degrees north of east, which is supposed to have been derived from the pagan Celtic reverence for the May-day sunrise.

CONCERNING CORPORATION LAW.

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IF ten Americans desire to engage in ten distinct business enterprises, it is conceivable that they will incorporate ten joint-stock companies, and each belong to all of them. While other countries have granted the privilege of existence to private corporations with extreme caution, if not reluctance, the many Legislatures of the United States have vied with one another in making it easy for them to be born. To adapt words heretofore applied to another matter: "The whole system of the free incorporation of private companies in the United States, with all its excellences and all its defects, is thoroughly characteristic of the American people. It grew up untrammeled by any theory as to how it ought to grow, and developed with mushroom rapidity."

We have no "system" of corporation law in this country; we have, instead, a tangled mass of statutes, which is yet further amended and ensnarled at the recurring sessions of our various Legislatures. We have a still larger mass of judicial decisions, which all the ingenuity and industry of the many writers on the subject can never quite systematize and reduce to order. Even when this feat may be approximately accomplished for a moment, the growth of judge-made law is so rapid that any treatise is speedily out of date. A redeeming feature of the situation is that the mimetic tendencies of our States lead the new ones to follow the examples set by the older, and thus a certain degree of uniformity is introduced into the different codes of law. The many sources of legislation also make it possible that a large amount of experimenting may be done without danger to the country as a whole. The immediate and disastrous consequences of the Granger railroad laws were thus limited to a few States in the Northwest, while their more general influence, as examples of what can but should not be done, has been of use to the whole country. One railroad president has gone so far as to say that in their results these laws have made a solution of the railroad problem possible.

The diversity of regulation has two effects—one commendable, the other not. The first is that when companies do business in all or many of the States at once, and in any line, like that of insurance, where ascertained corporate soundness is the best advertisement, a good code of laws in any one State makes the fact that a company does business there a helpful recommendation. The Massachusetts law regulating insurance is an

example of this. Its stringent requirements do not hamper the companies of that State, but are, on the other hand, an introduction and a guarantee that distinctly aid the Massachusetts companies when they carry their operations into other commonwealths. The same influence is apparently at work in the case of mortgage investment companies; a few of the best established among them priding themselves on complete and ostentatious compliance with the rigid but wise laws regarding publicity of accounts.

The second effect of the diverse rules regarding corporations in the different States operates in an exactly opposite direction. Since it is quite well established that a corporation may incorporate in one State and do all its business in another or others, there is a tendency for dishonest companies to take out charters in that State which bothers them with the fewest restrictions. A charter granted by the Legislature of Pennsylvania incorporating a company to do business in any State except Pennsylvania was held to be void; the Kansas court holding that no interstate comity permitted one commonwealth "to spawn corporations" upon other States which it would not allow to operate within its own borders. But the same thing is accomplished if a State, by a general act, permits companies to organize without specifying the place of business. Under some laws one corporation is not allowed to hold the stock of another; but, on the other hand, there are States that will willingly incorporate a company for the express purpose of holding the stocks of other companies. This is a very convenient fact when a "trust" is to be formed. A State noted for the laxity of its laws in this regard can serve as the birthplace of any number of companies. At present, according to Mr. W. W. Cook, "the snug harbor of roaming and piratical corporations is the little State of West Virginia. Under its laws a corporation may be created for any purpose for which a partnership may be formed, except speculation in land; the capital stock may be five millions of dollars or less; there is no tax except fifty dollars annually; residents or non-residents, aliens or citizens, may be directors; the principal place of business and directors' or stockholders' meetings may be in or out of the State; there is no liability of directors or stockholders except on unpaid subscriptions, and no public reports are required. . . . The incorporation of companies for the purpose of enabling them to do all their business in other States seems to be one of the chief industries of West Virginia." States can only guard themselves against the invasion of hordes of these irresponsible artificial persons by strict statutory regulation of "foreign corporations," but for the most part they have not taken any general precautions of this character.

Besides the defects in the corporation law of the United States which originate in its formless heterogeneity, there are other specific evils quite generally present, which it seems not impossible to lessen. It is the purpose of this paper to present suggestions, drawn from the experience of this and other countries, regarding four points that seem to be of strategic importance in the reform of corporation law:

1. The prevention of "frauds in founding" (*Grundungsschwindeln*). It is a suggestive fact that we have in English no recognized equivalent of the German word here parenthetically introduced. Neither is the English term "promoters" commonly used by American writers. Our examination of the problems of corporate management has been so superficial that we must make or borrow a nomenclature when we wish to discuss the evils connected immediately with the creation of companies. Yet a large portion of the evils connected with the existence of corporations originate at just this point. Men organize companies, at times, for the sole purpose of unloading upon them an unprofitable business. Let the experience of Eastern capitalists with Western mining stocks be put in evidence, and no one will question this statement. Mining companies with a nominal capital of fifty million dollars that have never declared a dividend are not uncommon; and very frequently the stock of mammoth companies sells at one cent on the dollar for some time before it becomes worthless. But the experience in mining is only an extreme case of what takes place in many departments of industry.

In England, turning thither solely because the facts have there been made accessible and have not in this country, it is found that certain men make a business of acting as "promoters." They are skilled in the writing of prospectuses of companies, and know all the arts by which stock can be sold. They devote their energies especially to small companies and small investors. For a time their activity was turned largely to organizing "single-ship companies," the shares of which could be placed among country parsons, serving-women, and other classes of small investors likely to know very little about commerce, and therefore likely to believe anything a well-printed "prospectus" might tell them. Many of these small companies never went so far as to build even a single ship, but enough ships were built by them to materially increase the number of "ocean tramps," and to call for much adverse criticism from the committee appointed "to investigate the loss of life at sea." The "commission appointed to inquire into the depression of trade" also had much to say of the influence of the creation of such great numbers of limited liability companies, of the direct loss to investors, and of the general demoralization of trade resulting from it. In fact, many English

investigators have laid great emphasis on the idea that over-speculation is due largely to the formation of joint-stock companies that have no real excuse for existence except the furtherance of the personal aims of the "promoters." It is a little curious that, among the three hundred real or alleged causes of "hard times," brought to the attention of our National Bureau of Labor, the reckless creation of limited liability concerns was not mentioned. In 1886 a writer estimated that there were afloat in the English stock market fully two billion pounds of speculative securities, of which at least a fourth were mere gambling counters. It is to such a state of things that a recent law review attributes the fact that real investors now shun the stock exchange, and speculative operators are compelled to live on the plan of "dog eat dog."

The stock exchanges of this country have had a somewhat similar experience, and the self-limiting nature of the speculation fever is indicated by the fall in value of a place in the Chicago Stock Exchange of three thousand dollars within a few years. As yet few steps have been taken to restrain the incorporation of absurd or fraudulent companies. Wasteful and semi-piratical paralleling of railroad lines is encouraged; incipient railroads are preyed upon by construction companies; companies of all sorts are bound hand and foot by the contracts entered into by an initial board of directors, and are brought into existence that they may be so bound.

None of the leading commercial countries seem to be quite satisfied with the attempts they have made to remedy such evils as these. Germany allows definite payment from the corporation funds for the trouble and expense properly incurred by the men who organize a joint-stock company, but guards very carefully against the illicit gains too often made by "promoters." The provisions for registering new companies are especially stringent in all cases where a private business or factory is to be sold to a corporation organized to buy and manage it. The fullest possible publicity is sought regarding all the initial acts of a new company, and some matters where the first decision must be final are reserved for a second meeting of the stockholders. Shares may run either to "bearer" or to a particular name. The latter can not be issued for a less amount than fifty *thaler* per share and the former for less than one hundred *thaler* per share. By forbidding the issue of shares of less amount, it is hoped to make investors consider more carefully the subject of investing, and to prevent the floating of small shares in worthless companies among the class of very small investors, who are most likely to be swindled. Some companies designed to engage in what are considered especially hazardous enterprises are forbidden to issue shares of less

than one thousand marks each. The opinion of the United States consul-general at Frankfort-on-the-Main is that all these restrictions have not availed to prevent a regular "incorporation fever," from which he expects very disastrous results ere long.

In France there has been some agitation in favor of returning to the old system in operation till 1863 of "special concessions" by which the right to organize a joint-stock company was a favor granted by the Government, and not a right conferred by general statute. The weight of authority and influence is, however, against this retrograde movement. Leroy-Beaulieu, in considering it, recalls the fact that the prefect of police of Louis Philippe refused Leclaire permission to organize the great profit-sharing company which was afterward established with signal success and which still bears his name. Leroy-Beaulieu adds, "We can bear the guardianship of law, but not of government." Certainly there should be no wish in this country to go back to the old system of special legislative charter, under which men made a business of lobbying for charters which were afterward sold to the highest bidder. One of the things upon which we can especially congratulate ourselves is of having got rid of this old source of legislative corruption, which gave us our wild-cat banks, and numberless other reasons for dreading it.

Our own experience may help us in dealing with frauds in founding if we will stop to consider the difference between the old State banks and our present national banks. The greater security of the latter comes largely from detailed legislation which prescribes the conditions under which artificial persons, designed for the transaction of a given business, will be permitted to be born. What we need at present as regards miscellaneous corporations is fuller knowledge of all the facts connected with their history, and especially of their genesis. Massachusetts is the only State that has collected statistics of private corporations at all comparable with those of the English register of joint-stock companies. Most of the States provide that all new corporations shall register with more or less fullness; but this is either a mere formality negligently performed, or else its sole object is to bring the corporation within reach of the tax-gatherer. The record is usually not published, or in some cases, as in Ohio, there is no way to trace in the published returns the outcome of the enterprises whose beginning is chronicled. In fact, our greatest need in preventing frauds in founding, as in preventing most other evils connected with corporate management, is completer publicity, and, as one result of this, fuller statistical data.

2. The proper regulation of the borrowing power. It has been stated on good authority, but is not true, that the evils of

corporate management of property began when it was found that corporations could borrow. Abuse of the borrowing power is certainly a very common sin among artificial persons, and especially among American railways. When the holders of a small amount of stock, only partially paid in, build a road with borrowed money, the limitation of their liability shields them from personal loss; while their power of voting themselves salaries, and of concluding profitable contracts either with themselves or friends, gives them great opportunities for personal profit irrespective of the success of the road. The last report of the statistician of the Interstate Commerce Commission shows that many of the minor and branch lines of the country have been built wholly with borrowed money —that is, they are bonded to their full cost value. Many of the longer and independent roads are bonded at half to three fourths of their entire capitalization. The total bonded debt of the railroads of the United States is actually greater than the total of their share capital; and this, although the amount of water in the stocks is much larger than in the bonds. As the possession of the majority of the stock gives control over all the capital invested in the roads, it follows, from the figures given in the statistician's report, that the ownership of $1,932,234,128, or 23·77 per cent of the total railway capital, insures complete direction over $8,129,787,731 of railway capital, or 136,883·53 miles of line. Massachusetts law forbids the bonding of a road to an amount exceeding the total of paid-up share capital, and this regulation is being introduced by other States. To forbid the issue of bonds that must be sold below par has been found to limit unsatisfactorily legitimate enterprises, but the effect of such a regulation is thought to be good if applied with care to specific classes of corporations. As to what is best in this matter, as in those that have gone before, we need more definite information.

3. How to secure a more representative and more responsible directorate. In regard to the election of directors it may be said that one device to prevent the tyranny of a majority of the stockholders has been frequently tried, and another frequently recommended. The former plan is to limit the number of votes which any one person may cast. In Massachusetts no person except a municipal corporation can vote over one tenth of the capital stock of a railroad corporation. The trouble with this plan, and the variations of it that have been tried, is that evasion is too easy. Dummy stockholders are very easy to manufacture, and it is difficult to unmask them. The much-recommended device for accomplishing a similar purpose is that of cumulative voting. By this device a shareholder is allowed to cast as many votes for any one director as the number of his shares, multiplied by the number of directors to be elected at the given time. Nebraska has a provision

of this sort in her Constitution, but the domestic corporations in the State have not had a sufficient development to thoroughly test its influence. It will probably do but little good to secure minority representation on the board of directors, unless the laws are so drawn as to limit the tyranny of a majority of the directors. The State of Maryland and the city of Baltimore have derived but scant benefit from their privilege of appointing a minority of the directors of the Baltimore and Ohio Railroad. But if minority representation be backed by the proper legislation governing the actions of the directors, there is no doubt that it is an efficient way of checking the misdeeds of stock majorities.

In Germany there is a second body chosen, under special rules, by the stockholders, known as the board of supervisors (*Aufsichtsrath*). This board has the fullest possible power of investigation and report, but very little power of any other kind. Its usefulness must obviously depend on the rules governing its selection, since, if so chosen as to have interests wholly in common with the directors, it would be of no use as a check upon them.

Turning to the question of responsibility, we find that in this country the principle of limited liability is almost invariably the same for the director as for an ordinary stockholder, though the director is personally liable for all illegal or unauthorized acts. There has been a great deal of agitation of late for the introduction of the French plan of protecting ordinary stockholders by the grant of limited liability, but leaving the directors liable for the corporate debts to the full amount of their respective fortunes. The experience of France with these *sociétés en commandite* has proved that responsible men can be found to manage any legitimate enterprise under this plan. A recent English act permits the formation of such companies in England, but the companies decline to adopt this principle under mere permissive legislation. To make this form of organization mandatory upon certain selected classes of our corporations is an experiment that ought to be tried, and is much better than going back to the old plan of unlimited liability for stockholders, as California has done.

Under the head of the responsibility of the directors must also be treated the question of the relation of the corporation to its employés. Albert Fink one day called together the presidents of certain roads he was trying to organize for their mutual good, and told the gentlemen who responded to his call that he wanted them all to resign. He further explained that this was advisable in order that their general freight agents might thereafter be nominally, as then actually, in charge of the several properties. The Interstate Commerce Association went down very largely because the "gentlemen" who were partners to the agreement could

not or would not control their subordinates. Part of this alleged powerlessness is no doubt assumed that the head may escape responsibility for the action of the members, but part of it is quite certainly genuine. The development in bulk of the ponderous artificial beings has exceeded the development of their nervous systems, and the monsters can only sprawl and plunge instead of going forward to a definite end. This condition, however, is progressively cured by automatic processes. We have as yet no economic treatise on corporation by-laws in general, but well-recognized rules are developing for the organization of specific classes of corporations.

In the narrower view the relation of the corporation to its employés is merely a question of wages, of strikes, and lock-outs, and of relative losses from these disturbances to employers and employed. The statistics of strikes and lock-outs collected by our National Bureau of Labor show that almost the only industry in which the losses inflicted by strikes are heavier on the employers than on the men is that of transportation. The undetermined losses inflicted upon the general public by this class of strikes must be also especially large. Two ways of dealing with these evils have been tried in Europe, either of which seems to be a partial remedy, but neither of which seems likely to commend itself to Americans. The first is to impose a heavy per diem fine or even forfeiture of charter upon any corporation that fails to perform its public functions. This forces the company to make terms of some kind with the strikers. When strikers in this country have tried to secure the forfeiture of charters through the courts, on the ground that the companies did not discharge their public functions, they have met with little success, though in some cases a street-car company has thought it necessary to insist on running a single car each day in order to secure its charter against attack on this ground. The second European method of guarding the public against the loss of strikes is to make it a misdemeanor for any employé to quit work without giving (say) five days' notice. The trial of this method has been advocated in this country, but it may be doubted if our system of police could be relied on to enforce such a law, or if, at the critical time, public opinion would indorse it. That the great corporations see the necessity of acting in the matter, so as to avert the danger that continually hangs over them and the public, is seen in the rapid development of relief associations and other devices for making the position of the employé more stable than it has ever yet been in this country. The President of the Union Pacific Road has advocated the withholding from subordinate officials of the arbitrary power of dismissing the men, the object being to make the men an integral part of the corporation, and to give them security in their posi-

tions during good conduct, and a prospect of promotion if especially efficient. The problems that our Government must confront in the matter of civil-service reform are also to be dealt with by our corporations, and the conditions are enough alike so that the experience of each may serve for the guidance of both.

4. Adequate publicity of corporate transactions. The need of thorough publicity of corporation accounts has been already dwelt on at some length. Nearly all the abuses to which corporate management of property is liable originate and wax mighty only when concealed. On the other hand, secrecy, even when it does not cloak abuses, is commonly suspected of doing so. Most of the unreasoning and unreasonable attacks on corporations have been made when those in charge of the corporations insisted on the privilege of keeping their affairs entirely to themselves. The advantages of business secrecy to the individual business man who practices it are abundantly manifest, but its advantages to the public at large, while also manifest, are countervailed by very serious disadvantages. Experience seems to have demonstrated quite conclusively that a being at once so vulnerable and so powerful as a corporation can not afford to keep its affairs entirely to itself, and if it could afford to do so the public can not afford to let it. There is said to be a strong tendency toward "socialism" in this wresting of business secrets from the great managers of the world's industries, and bringing the most private of business transactions to the bar of public opinion. Many will no doubt answer that "the charge is true, and we glory in its truth." Many more will be inclined to say, with the present writer, that, while this objection should be given its due force, it has not nearly force enough to overrule the strong necessities of the case. The chief danger that legitimate enterprises have to fear from complete publicity is that of overtaxation. The wealth of the corporations lying fully exposed to public view, it is so easy for the politician to fill the public coffers from that source that we already find certain classes of corporations driven out of certain States by excessive taxation. But it may be doubted whether taxation is as likely to be excessive when the state of a company's accounts is definitely known, as when the politician and his constituents are free to draw upon their imaginations for the amount of wealth in the corporate coffers. In other words, it seems probable that in this country, as yet, we have less to fear from willful injustice than from mutual misunderstandings begotten of secrecy on the one hand, and suspicion on the other. European countries are distinctly ahead of us in this matter. They have by no means solved all the problems connected with the corporate management of property, but they have at least collected more of the data that will make a solution possible.

When, in 1873, Adolph Wagner read before the German Verein für Socialpolitik an elaborate paper on joint-stock companies, he made many suggestions as to the reform of corporation law. But he concluded by defending the thesis that, while the reform of corporation law was indispensable, this alone, however perfectly accomplished, could not suffice to eliminate the evils of corporate management of property; he contended that corporations must continue to be mischievous until they are restricted to a narrower field of activity than that now occupied by them; that the state, in its various branches, must assume control of those enterprises that are of necessity monopolies.

To the interminable discussion recalled by the name of Wagner and the mention of his thesis it is here desired to contribute but a single suggestion. Spencer and others dwell always upon the distinction between "compulsory co-operation" through the state, which is said to be characteristic of a "militant *régime*," and "voluntary co-operation" through private associations, which is said to be the proper thing under an "industrial *régime*." Now, is it not true that the distinction between these two kinds of "co-operation" is fading out? Co-operation can be wholly "voluntary" only when isolation is a possible alternative. Is not industrial isolation becoming almost as impossible as political isolation? Co-operation through the state is becoming less and less "compulsory" in the old significance of the term, because it is becoming more and more possible to choose what government we will live under. This comes from increased facilities, both physical and legal, for moving from one state to another. Formerly, a man must obey the state under which he was born; his "co-operation" with it was, indeed, compulsory. Now, expatriation is a comparatively simple and pleasant alternative to obedience. States and nations are coming to compete with each other for desirable citizens, as producers of services or commodities formerly competed with each other for purchasers. There can be no doubt that Bismarck's hand was less heavy upon Germany because so many of her citizens emigrated, and so many more of them might have emigrated to this or other countries. Within the States and cities of our own republic we see our Legislatures and town councils continually coerced by considerations of attracting or retaining desirable classes of citizens. It is easier to escape from the power of the Legislature of Pennsylvania than from the influence of the Pennsylvania Railroad; it is easier to get beyond the reach of the tax-gatherers of all our States than to cease to pay tribute to the Standard Oil Company or to the anthracite coal pool. The point may be restated thus: The "coming servitude" to which we are advancing through the increasing dominance of the state will be modified by the power

of the individual to choose what state he will serve. On the other hand, industrial co-operation, in its broadest sense, is becoming more and more compulsory; the distinction, therefore, between "voluntary" and "involuntary" "co-operation" is of ever-lessening importance.

INSECT PESTS OF THE HOUSE.

By Miss MARGARETTE W. BROOKS.

THE various insects which infest the dwelling have been from time immemorial a trial to careful housekeepers. Just as out of doors the gardener is constantly employed in protecting plants of all kinds from the ravages of insects, so in the house there is a perpetual warfare carried on against these indoor pests. Some eat holes in our clothes, others destroy carpets and hangings, while still others are attracted by the food in our pantries and storerooms.

Unless one has watched the habits of insects and studied their development, it is hard to realize that in their mode of growth they differ from the other animals with which we are familiar. By some it is supposed that an insect grows as a bird or a cat grows —that is, by imperceptible increase in size, with no marked change in form. With this idea it is not strange that a tiny fly should be thought a young fly that will gradually grow bigger, or that a large fly should be supposed to have lived some time to have attained such size. It is a fact fairly well understood that moths and butterflies pass through several changes between the egg and the perfect insect, and that the caterpillar, or worm, as it is more often called, seen feeding in our gardens, or crawling over sidewalks or fences in search of a convenient spot in which to undergo its transformations, will before long assume a totally different appearance; it is not so generally known, however, that in the larger number of insects the change is nearly if not quite as great.

Among the insects which infest our houses we find representatives of most of the various orders of insects, and a study of these forms alone would prove of interest and value. Their habits are well known to the housekeeper, and so in many cases is their appearance in one or more stages; but a history of their life from the egg to the perfect insect is still a mystery to many people, and it is to these that the following pages may be of interest. In this article attention is called only to the more common insect pests of the house.

CLOTHES-MOTH (*Tinea pellionella*).—One of the commonest of

household pests is this little moth. Most housekeepers are familiar with the different stages of its growth, and all are aware of the fact that it is not the little delicate silvery moth that does the damage, except indirectly by laying its eggs in our woolen garments.

The moth, measuring less than half an inch across its spread wings, easily makes its way through the smallest crevices, and unless care is taken in the spring and summer we may find garments that have been carefully laid away in boxes and drawers, as well as clothes hanging in closets, are infested by this creature. As a general rule, the worm seems to prefer partially worn and soiled garments to new cloth.

FIG. 1.—CLOTHES-MOTH. *a*, the moth (natural size); *b*, larva; *c*, case; *d*, pupa (*b*, *c*, and *d* are enlarged).*

Early in the spring garments should be well beaten and brushed to dislodge the moths or any eggs that may have been deposited in the folds of the cloth, and then hung in the air and sun for a while.

When possible, garments should be folded in paper, leaving no chance for the moth to enter; large paper bags being convenient for this purpose. Camphor-wood or red-cedar chests are valuable in protecting articles which can not easily be wrapped in paper, as the odor of these woods is disagreeable to the moth; and when these are not to be had, oil of cedar poured on paper, which is then rolled up so that the oil shall not grease the garments, will make an ordinary box moth-proof. These rolls of paper should be scattered through the box and should be renewed two or three times during the spring and summer. It is said that black pepper or whole cloves sprinkled among woolen clothes will prevent the moth from depositing its eggs, as will also pieces of tallow wrapped in paper, and the odor of carbolic acid, turpentine, or benzine is very offensive to the moth. Camphor, as is well known, is beneficial in keeping away moths, but should never be placed near seal-skin, as it causes this fur to change color, showing streaks of gray or yellow. The great secret in taking care of furs is said to be frequent and thorough beating, the furs being kept in close closets lined with tar-paper.

It has been said that the odor of tobacco is disagreeable, but in the experience of some it has seemed rather to attract than to re-

* Figs. 1, 5, and 6 are from Our Common Insects, by Prof. A. S. Packard, and we are indebted to the kindness of the author for permission to use them.

pel the moths. In more than one case it was found that clothes belonging to men using no tobacco were free from the attacks of moths, while in the pockets of those who smoked constantly were found both eggs and larvæ mixed with bits of tobacco, the garments having been eaten in various places. Of course, this is not an absolute proof of the inefficacy of tobacco, as there may have been other causes of attraction, and fresh, clean tobacco may, after all, be found effectual.

The larvæ or the eggs can be killed by putting the article in which they are found in a tightly closed vessel, and plunging it for a short time into boiling water, or it can be placed in an oven heated to a temperature of 150° Fahr.

It is hardly necessary to describe the moth, which, although so small, is easily recognized as an enemy by most housewives, though in many cases little moths of various species attracted to our rooms by the lamp-light in the evening are often mistaken for the clothes-moth and destroyed. It may be well to state that the clothes-moth rarely flits about the light.

Soon after the moth issues from the cocoon the female finds its way to the substance suitable for food for its young, and upon this material it lays fifty or more eggs. In about a week the egg is hatched, and almost immediately the worm begins to eat, and not only uses for food the fibers of the article upon which the egg was laid, but also makes of the material a covering for itself—a little tube in which it lives, spinning for a lining the softest silk, which it emits from glands in the head. From time to time, as the little worm grows, it enlarges its case, either by adding to the ends or by cutting with its sharp jaws little slits in the sides of the case, filling in the space between the edges with the substance nearest at hand, forming a neat patch. Not content with eating and making a shelter for itself of the cloth upon which it lives, the little worm cuts through the cloth as it makes its way in various directions, dragging its case after it. If the case is torn from it, or in any way injured, it soon makes a new one or patches the old. After a while, at the approach of warm weather, the little worm closes the ends of its case and changes to a pupa or chrysalis, and in two or three weeks the moth appears.

Buffalo-Bug (*Anthrenus scrophulariæ*).—Within fifteen or twenty years there has appeared a new addition to the already long list of injurious insects introduced into this country from Europe. Although called a bug, which is the name commonly applied to all insects having inconspicuous wings, it is in reality a beetle, and why the name buffalo is applied is not known for a certainty; some say it was first noticed in this country in the city of Buffalo, New York, while one writer says it was named from its fancied resemblance to a buffalo. Whatever may be the

reason for this name, and however inapt it may be, it is known more commonly by it than by its more proper name of "carpet-beetle."

The larva which does the damage measures when full grown about three sixteenths of an inch in length. It is covered with hairs, the longest ones being on the last segment of the body, forming a sort of tail. It makes no cocoon, but when full grown remains quiet for a short time, then the skin splits along the back

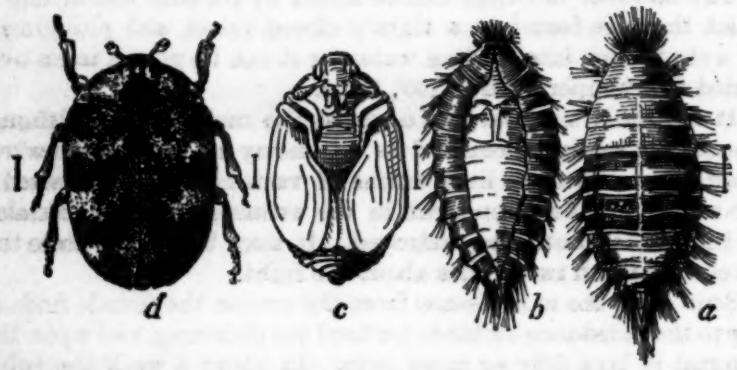

FIG. 2.—CARPET-BEETLE. *a*, larva, upper side; *b*, larva, under side; *c*, pupa; *d*, perfect insect (after Riley). The straight lines at the sides show the actual length of each form.

and the pupa is seen. It continues in this state for a few weeks, when the skin of the pupa bursts and the perfect insect is disclosed—a beautiful little beetle, less than an eighth of an inch in length, marked with red, black, and white. From October until spring the beetles may be found in all stages of growth—that is to say, in the larval, pupal, and perfect states.

It is found that few of the usual preventives are of any use against the attacks of this beetle, and for this reason it is a difficult pest to eradicate. In some places it has proved so destructive that carpets have to be dispensed with, and in their place rugs are used, as being more conveniently examined.

Tallow or tallowed paper placed around the edges of the carpet, which are often the parts first attacked, is said to be effectual. In many cases the carpets are cut, as if with scissors, following the line of the seams in the floor, and as a remedy for this it has been recommended that the seams be filled during the winter with cotton saturated with benzine. Kerosene, naphtha, or gasoline are offensive to the beetle as well as benzine, but benzine is perhaps the simplest and safest preventive to use. It can be poured from a tin can having a very small spout, it being necessary to use but little.

Before tacking down a carpet it should be thoroughly examined, and if possible steamed. If in spite of precautions a car-

pet is found infested, a wet cloth can be spread down along the edges, and a hot iron passed over it, the steam thus generated not only killing the beetles and larvæ, but destroying any eggs that may have been laid. Clothing is sometimes attacked as well as objects of natural history—such as stuffed birds and mammals.

It was believed that the beetle must feed on some plant, for in a number of cases it was captured out of doors, and it was finally discovered feeding on the pollen of the flowers of spiræas, the beetle living on the plant for a while and then returning to the house to lay its eggs. When this was proved, it was suggested that spiræas should be planted around houses infested by the beetle; by doing this the plants could be often examined and the beetles destroyed.

COCKROACHES (*Blattidæ*).—Among the *Orthoptera*, to which order this family belongs, we find a different mode of transformation. Were it not for its small size and the absence of wings, the young would closely resemble the parent, and, after molting or changing its skin several times, it reaches maturity without having passed through a stage in which it keeps perfectly quiet, as in the case of the moth and beetle.

FIG. 3.—COCKROACH. *a*, male; *b*, female.

The eggs of the cockroach are carried about in a little case by the female, and when these eggs are ready to hatch, this case is dropped; and it is said by some writers that the little ones are helped out by the mother. Just after the young come from the egg, and after each molt, they are white, but the usual color is brown or black. They molt five or six times before reaching maturity.

Cockroaches are very troublesome, eating anything that comes in their way; are unpleasant to look upon, and are specially disgusting to us on account of their disagreeable odor.

The large cockroach (*Periplaneta orientalis*), or "black beetle," as it is sometimes called, might in some cases be not unwelcome, as it acts as a scavenger, keeping the corners of the rooms it frequents clean, and furthermore it feeds on that most disgusting of pests, the bed-bug. Though this is said in its favor, we think there is no doubt that the remedy might be thought as bad as the disease, and it would be considered more agreeable to find some other way of exterminating the bed-bug; and most people would

prefer having their corners cleaned in the ordinary way, with soap and water; nevertheless, it is sometimes of service in this way. This cockroach is of a dark-brown color, about an inch in length; the male having short wings, while the female has only rudimentary wings. It is very troublesome in kitchens, coming out at night when the lights are out.

A somewhat larger insect is the American cockroach (*Periplaneta americana*), which is a lighter brown color, both the male and female having well-developed wings. This species is not so often found in houses, but frequents water-pipes and sewers and the cargoes of vessels.

The smallest cockroach which is a pest in our houses is the "water-bug" (*Ectobia lapponica*). It is also known as the "Croton-bug." This insect is very common in houses in New England, and, though eating any kind of food, is especially fond of bread. It frequents bakeries, where it proves a great annoyance, sometimes being baked in the bread in spite of care. It also eats the covers of books bound in cloth, but will not touch those bound in leather.

It has been said that sailors have been greatly troubled by cockroaches eating the nails of their fingers and toes, and the hard parts of their feet and hands, but this has been questioned. However, a writer in Nature affirms that while in Australia he was awakened one night by cockroaches nibbling his feet, which were badly blistered, and in the morning he found the skin had been eaten from a large blister, causing a painful sore, and that the hard skin of the heel had also been eaten. Another writer in the same journal says that this habit of cockroaches is well known to all West Indians.

Borax is very disagreeable to cockroaches and will drive them away, and it is said to kill them if mixed with white sugar and sprinkled around the corners frequented by them. The following receipt for a preparation to exterminate cockroaches is given in a late number of Science: thirty-seven parts of borax, nine parts of starch, and four parts of cocoa. This preparation should be sprinkled around their haunts.

Insect-powder does not kill them but renders them stupid, and while in this condition they can easily be swept up and destroyed. In England cockroaches are sometimes caught with stale beer, which is placed in a deep dish, bits of wood being so arranged that the cockroaches can climb into the liquid. The following preparations are mentioned in Harris's Insects Injurious to Vegetation, but, as they are poisonous, they should be used with the greatest care. The first is a tablespoonful of red lead and Indian meal, mixed with enough molasses to make a thick batter; the other is a teaspoonful of powdered arsenic mixed with a table-

spoonful of mashed potatoes. These preparations should be used for several nights in succession.

BRISTLE-TAIL OR SILVER-FISH (*Lepisma*).—Often when looking into a box or drawer which has remained in a damp place for some time, or on opening an old book, we see a curious little silvery creature running swiftly out of sight. It is so unlike the insects which we usually find in our houses that one hardly knows what to call it. It is nevertheless an insect, though belonging to a low order. Its long, slender body is covered with delicate iridescent scales, from which is derived its name "silver-fish"; it has no wings and passes through no metamorphoses. It feeds on silken clothing, tapestry, and the like, but is more destructive to books, eating the paste of the binding and even the leaves, though loose papers are more often attacked. A few years ago one species was found doing a great deal of damage in museums by eating the labels. The labels which were rendered illegible by the attacks of this insect were made of heavily sized paper, in most cases common unglazed paper remaining untouched by them; and it was also found that only clothing finished with starch or sizing was subject to their attacks. Prof. Hagen, writing on this pest, recommends that insect-powder, which easily kills them, should be sprinkled about silk dresses or any articles liable to be injured by them. Where papers are pressed close together the *Lepisma* can do no damage; but in cases where pressure might injure the papers or pictures they might be inclosed in boxes, taking care that the covers fit so closely that no space is left for the insect to enter, or the boxes might be sealed up by pasting strips of paper around the covers, a paste with which insect-powder has been mixed being used for this purpose; valuable framed engravings might be covered on the backs with common paper, the same kind of paste being used. There is no doubt that labels washed in an alcoholic solution of corrosive sublimate would be rendered proof against the attacks of this insect.

DEATH-WATCH (*Anobium*).—Books are also eaten by the larva and the mature insect of several species of beetles belonging to the genus *Anobium*. These beetles produce the ticking sound sometimes heard in the wood-work of houses, specially noticeable at night, when everything is quiet. This sound is probably a sexual call, and is made by the beetle rapping the wood with its head. Injury is also done by them to furniture and food, and they sometimes prove a great annoyance. Their depredations may be prevented by washing articles liable to be attacked in a solution of corrosive sublimate in alcohol, or objects such as books may be exposed to the odor of carbolic acid or benzine, or they may be fumigated with burning sulphur.

There are still other insects which do more or less damage in

libraries* by eating the books, but those already mentioned are the principal ones.

ANTS (*Formicidæ*).—Of the large black or brownish ants that trouble us in store-rooms but little can be said, as, so far as I have examined the authorities within my reach, I have found but little mention of them. Judging by my own experience, they are very difficult pests to expel from the house. Cayenne pepper is said to be disagreeable to them, and arsenic mixed with any kind of attractive food will kill them. Oil of peppermint is found very effectual in driving them away, but everything in its vicinity is so permeated with the odor that its use can not be recommended. It is often said that borax will drive them away, but this has been tried without success; however, according to a writer in the Popular Science News, the borax should first be heated, to deprive it of its water of crystallization. Hot alum-water is very offensive to most of the insect pests of the house, and should be applied with a brush when nearly boiling hot.

Ants are extremely fond of sugar, and anything containing it will attract them. A glass of jelly left uncovered within their reach will be found tunneled in every direction, and, by pouring boiling water upon it, the ants within may be killed.

An excellent and simple trap for them is a sponge wet with some sweet sirup. When the interstices of the sponge are filled with the ants, it can be carefully taken up and plunged into boiling water, and again set for them after saturating the sponge with the sirup.

Another trap which is still more simple is a plate covered with a thin layer of lard, which should be placed in the closet frequented by them. This would probably prove more effectual in catching the little yellow ant (*Myrmica molesta*), which is sometimes very troublesome in the house.

Mention should be made of the white ants, which, although resembling the true ants in appearance, really belong to the order of *Neuroptera*. The only species found in the United States does great damage by eating the interior of the wood-work of buildings. These ants enter the timbers of the foundation from below, and extend their galleries to the top, leaving the outside untouched, so that their presence is unsuspected until the supports suddenly give way.

Several years ago the "dungeon," as it is called in the State-House in Boston, was found to be undermined by them, and Dr. Hagen apprehended considerable trouble if their depredations

* Prof. Verrill found in the library of Yale College a caterpillar belonging to the genus *Anglossa* eating the leather bindings of old books. When ready to transform, this larva spins a silken cocoon, and after a short time there issues from it a little moth measuring half an inch across its spread wings.

were not immediately checked. In addition to the danger of the supports giving way, there was reason for alarm in the fact that they also destroy books and paper; but in this case, fortunately, the papers stored in the part of the State-House in which they appeared were of little value. Measures were taken at the time to prevent their devastating work, and it is hoped that they have been exterminated; but Dr. Hagen, in an article on the subject a few years later, thought it not improbable that they had spread farther, as nothing was done to prevent their entering other parts of the building.

These ants feed on rotten wood, living in old stumps of trees, and sometimes in old fences, and Dr. Hagen suggested the removing of every old stump around buildings and in the vicinity of cities, thus diminishing the number by depriving them of their necessary food. Places kept moist by hot steam are particularly favorable for the work of these little creatures; and more or less trouble was occasioned in Cambridgeport, at the telescope works of Alvan Clark and Son, where a timber constantly moist from the steam was honey-combed by them; and some years ago a bridge near Porter's Station in Cambridge was destroyed, probably from the same cause. As many trains stopped under this bridge, it was constantly moist from the steam of the locomotives.

So far the insects mentioned are those that do direct injury to our clothes, carpets,* food, books, etc., but there are still others which frequent our houses and prove very annoying in various ways; and besides these there are numerous insects which cause much trouble in collections of natural history, and in museums the utmost care must be exercised to prevent their attacks. It is not often that these museum pests prove of much annoyance in the house. I have found the larva of a beetle (*Attagenus pellio*) in the sawdust of a doll's arm; and the larva of another species (*Attagenus megatama*) is sometimes found to have eaten the feathers in pillows, and the short particles of the feathers become so firmly fastened in the ticking by the repeated shakings of the pillow that a fine, soft felting is made, resembling the fur of a mole.

Bed-Bug (*Cimex lectularius*).—The eggs of the bed-bug are white in color and oval in shape. The young differ but slightly from the parent. The full-grown bug is wingless or possesses rudimentary wings, is less than a quarter of an inch in length and of a brown color. It is about eleven weeks in attaining its

* A brief mention may be made of a fly (*Scenopinus pallipes*) whose habits are but little known. The larva is a long, white worm living under carpets, upon which it is supposed to feed, and it is also found in rotten wood, but as yet it has not appeared in numbers sufficiently large to prove an annoyance in the house. The full-grown fly measures about a quarter of an inch in length.

growth. Dr. Packard, in his Guide to the Study of Insects, says that bed-bugs may be destroyed by "a preparation consisting of thirty parts of unpurified, cheap petroleum, mixed with a thousand parts of water"; and in the Popular Science News was published the following formula for a bed-bug poison: Into one half pint of alcohol put one ounce of camphor, with one ounce of pulverized sal ammoniac and one ounce of corrosive sublimate; to this add one half pint of spirits of turpentine and shake well before using. These solutions may be applied around the cracks and crevices of a bedstead; benzine, too, may be used with good effect, and boiling water will destroy them, but the best preventive is perfect cleanliness. Curiously enough, they live parasitic upon domestic birds.

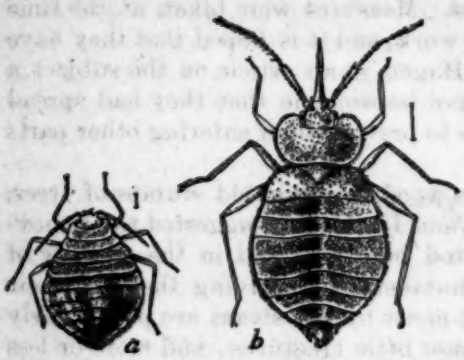

FIG. 4.—BED-BUG. *a*, young; *b*, adult (after Riley), both enlarged.

FLEA (*Pulex canis*).—The fleas, although having no wings, have until lately been classed with the flies (*Diptera*), but are now placed by many writers in an order by themselves, the *Aphaniptera*. During the past summer and fall there has been considerable annoyance caused in and around Boston by this troublesome insect, and owing to its habit of attacking man it was supposed to be the true human flea, but a letter of inquiry on the subject, addressed to an eminent entomologist brought the following reply: "So far as I know, we do not have the human flea in North America, and ours is *Pulex canis*, the dog and cat flea. It seems to breed in sandy cellars and such places at certain seasons."

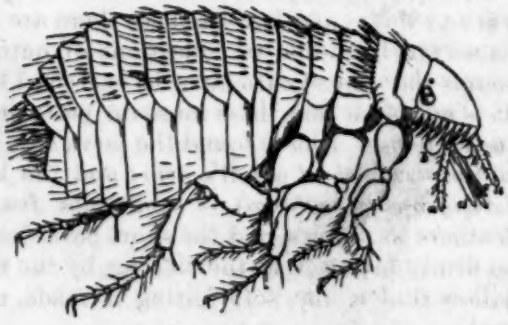

FIG. 5.—FLEA (much enlarged).

The eggs of this flea are laid on the dog or cat, and, being sticky, adhere to the hair until almost ready to hatch, when they fall to the ground. These eggs are very small, white, and oblong, and but eight or ten are laid by one female.

The young larvæ are hatched in about a week, and their growth

is usually attained in less than two weeks; they then pass two more weeks in the pupal stage, when the perfect insect appears. When dogs are badly infested by them, the use of common olive-oil is recommended. This should be well rubbed into the hair and over the skin, being allowed to remain for half an hour, when it should be washed out with the best yellow soap and lukewarm water. Dalmatian insect-powder has also been found efficacious. This powder can be rubbed into the hair, and it can be sprinkled around their kennels. It is not, however, best to use it on cats, but possibly it might do no harm to sprinkle it around their sleeping-places. A better plan is to have the cat's bed made of shavings or some such material that can often be replaced, the old bedding being carefully taken up and burned.

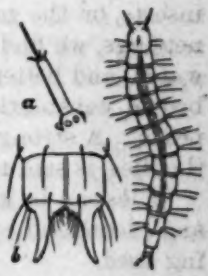

FIG. 6.—LARVA OF FLEA.

Some years ago there were on exhibition a number of so-called educated fleas, and it is thought by some people that the intelligence of fleas must be very great if they can be trained in this way; but an article by Mr. W. H. Dall, in the American Naturalist, a few years ago, showed that in every case the motions made by the flea were caused, not by the training it had received, but by the struggles made in its efforts to escape.

HOUSE-FLY (*Musca domestica*).—Familiar as we all are with this insect in its mature state, it will be found that to many its history before it appears in our houses is still very obscure, and until some years ago, when Dr. Packard made a study of its life-history, naturalists, too, were somewhat unfamiliar with its early stages of growth, and to him we are indebted for the following facts:

We find the flies most annoying and abundant in the hot dog-days of August, and, unless the greatest care is taken, our rooms are filled with them, even though we may be some distance from a stable, where the desired food for the young is found. The eggs are laid in bunches in manure, often buried out of sight, and, the conditions being favorable, they are hatched in twenty-four hours. The worm or maggot has no legs, and, after changing its skin, appears larger, though otherwise remains about the same in appearance. After two or three days it again sheds its skin, and in this stage of development it remains two or three days longer. It then transforms into a chrysalis, in which state the body contracts somewhat and becomes brown and hard, and, after six or seven days, the perfect fly appears and lives for five or six weeks, perhaps longer. A few flies probably live over the winter in crevices of buildings until the warm spring days bring them out.

Dr. Packard kept a fly in a bottle from 6 P. M. one day until 8 A. M. the following day, in which time one hundred and twenty eggs were laid.

Oftentimes flies are found dead on the window-sills or adhering to the walls or ceilings, a white powder surrounding them; death in these cases having been caused by a parasitic plant growing upon them, the white powder observed about them being the spores of the plant.

It is, perhaps, hardly necessary to speak of the various methods of preventing the entrance into our houses of these annoying insects, or the manner of expelling when, in spite of screens and nettings, we find them in our rooms. One must be always on the watch, and better than any fly-trap or fly-paper is the little whisk broom, constantly at hand to be used on these disturbers of the peace. A strong solution of quassia, mixed with sugar to attract the flies, is said to be an excellent fly-poison.

Flies can be kept out of stables by keeping the floor well swept and clean, and sprinkled with kerosene-oil, only a very little being used.

MOSQUITO (*Culex pipiens*).—Another dipterous insect which frequents our dwellings is the common mosquito, an insect too well known to need any description. During the season a female will lay about three hundred eggs in several litters. These eggs are deposited in standing water, running water being free from them on account of the danger of the mosquito being drowned when emerging from its pupa-case, which serves as a sort of raft until the wings and legs are strong enough to support the perfect insect.

The egg hatches soon after being deposited, and the young lives upon decaying matter, growing very rapidly and changing its skin several times. While in the pupa state it takes no food, and, unless disturbed, remains near the surface of the water. In about four weeks after hatching, the pupa-skin splits along the back, and the mosquito appears. It is perhaps hardly necessary to mention that it is only the female that bites, or, more properly speaking, stings.

A writer in Nature says that the "smell of American pennyroyal (*Hedeoma pulegioides*), when sufficiently strong, drives them away at once." This remedy is often given, but I have never yet seen it used with any effect. Another writer in the same journal advises the use of a solution made by pouring boiling water upon quassia-chips. This wash may be applied and left to dry on the skin, acting as a preventive against the annoyances of mosquitoes, gnats, etc. In a later volume of Nature a writer reports having tried this wash with no beneficial results; still, it may be of use in some cases, and, being so simple, could easily be

tried. Still other washes are made, some of which may be found a protection. A number of rules are given in The Popular Science News during the year 1882. The house can be kept tolerably free from mosquitoes by using care, and a netting over the bed protects one during the night; but, when one wishes to spend his summer vacation in the country, he is willing to try anything that will protect him from these most annoying creatures, which make a morning spent in the woods a torture instead of a pleasure.

APPARATUS-MAKING IN EDUCATION.

By M. C. WILSON,
PROFESSOR OF NATURAL SCIENCES, ALABAMA STATE NORMAL SCHOOL.

BY way of further illustrating the truth of what Prof. Woodhull says in his article, Home-made Apparatus, in the August, 1889, number of The Popular Science Monthly, allow me to present some work that has been done here in that direction.

We have no workshop and no tools. Our method of work is this: In the study of natural philosophy, when a principle is being enunciated, some half-dozen or more members of the class are asked to make the piece of apparatus which illustrates this principle. A week is allowed for its completion, or a longer time, if the work involves much difficulty, or if the pupil has much work in other classes. He is allowed to use any material he can get, and he may ask the aid of a blacksmith, carpenter, or any mechanic. But the work, when brought in, must be neatly finished, and must be made of materials that cost absolutely nothing. Of the six or more pieces of the same kind, the neatest and most accurate one is preserved in school. In this way, in the course of time, some hundreds of pieces of apparatus are made which serve perfectly well to illustrate the principles of natural philosophy. These pieces are handled, tested, and compared by the pupils in the class-rooms, and in this way they voluntarily spend spare minutes before and after school hours. They consist of such articles as inertia apparatus, steelyard, balance of equal arms, pulleys, inclined planes, wheel and axle, hydrometer, siphon, fountains, Leyden jar, pith-ball electroscope, gold-leaf electroscope, batteries of various kinds, magnets, electro-magnets, telegraph apparatus, etc. These, if purchased from an instrument dealer, would amount to several hundred dollars.

For materials for construction of apparatus, the pupils ask at home or at stores or shops where they are acquainted. There are always bottles, tin-foil, corks, wax, wood, scraps of wire, iron, tin-plate, bits of thread, cloth, etc., to be had for the asking. Almost

every kind of business in some way contributes its share. There is no difficulty whatever in getting these things, for the merchants and mechanics are usually pleased when the boys ask for them.

One of the pieces of apparatus made in class was a steelyard, which was constructed of a foot-rule. Exactly one inch from the end a hole was bored; through this a wire was passed and bent into a loop. This served for the pivot. Three fourths of an inch from the same end another wire, similarly bent and inserted, served for the suspension of the weight. The pea was made of a small piece of pig-iron picked up at the furnace. It was carefully weighed, and had a small cord tied around it so that it could be slid along the beam of the steelyard. This apparatus was made to illustrate the lever of the first order, and when tested weighed as accurately as the grocer's scales.

Another piece was a balance of equal arms, which was sensitive to five milligrammes, either loaded or empty. It is represented in Fig. 1. The beam, support, pointer, and index were cut out of wood. The scale-pans were tin-box tops. The knife-edges

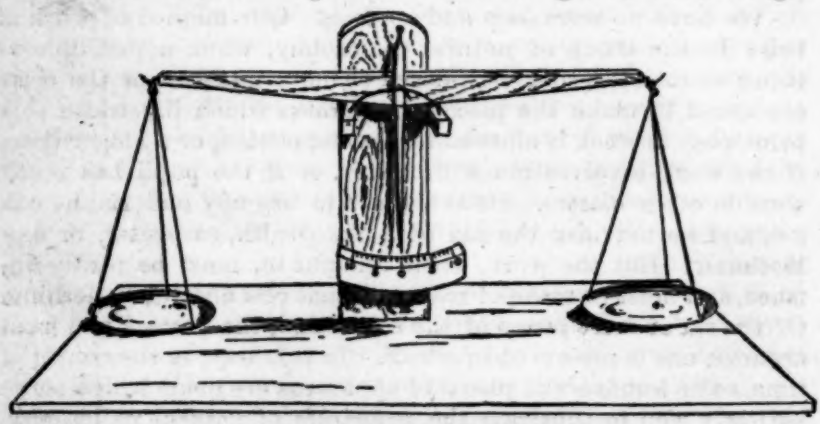

FIG. 1.—BALANCE OF EQUAL ARMS.

were made of old umbrella wire tempered hard. The weights, from ten grammes to five milligrammes, were made of pieces of copper wire. In making this balance, the pupil had his attention forcibly called, by repeated failures, to the necessity of having the arms exactly equal, to the best position of the center of gravity of the balance, and to the importance of the knife-edges. This balance—the best of four brought in—was used to determine the specific gravities of minerals, and the results obtained agreed closely with those given in Dana's Manual. It was also used in the candle experiment to show that there is gain in weight when a candle burns, and for numerous other experiments.

A hydrometer, made by another boy in the same class, accord-

ing to a suggestion found in Gage's Elements of Physics, illustrated well the advantage of requiring pupils to make apparatus, even when free access is had to that made by the instrument-maker. A piece of wood cut from the spoke of an old wheel was loaded at one end with lead, so as to make it stand upright. It was immersed in rain-water, and the water-level on it marked 1,000. By means of a Baumé's hydrometer the level of 900 was found, and distances, equal to the distance between the two marks, laid off above and below. Much to the boy's surprise, the hydrometer thus graduated would by no means coincide with his Baumé. He attributed the error to the absorption of the fluids by the wood, and set to work to make another, taking care this time to rub the wood with beeswax, to render it impervious to liquids; but his second graduation was hardly more satisfactory than the first. He then put on a piece of cork for a float, the wood having failed to keep an upright position in all liquids, and graduated his hydrometer by means of different liquids whose densities had been found with the Baumé hydrometer, and at last discovered that the divisions were not equal. This piece of work, represented in Fig. 2, consumed all the boy's afternoons for a week; but I saw the effect of it in increased carefulness, and consequently greater accuracy in his subsequent work, and, what was still more important, in increased thoughtfulness.

FIG. 2.—HYDROMETER.

A condenser for use in distilling water was made after the pattern of Liebig's. The outside tube was made by boring a round piece of wood, ten inches long and two inches in diameter, through with an inch auger. The inside tube, and those for entrance of cold water and exit of hot water, were made of reeds. A bottle served for the still, and the whole was supported on a neat wooden stand.

Such work undoubtedly requires much energy on the part of the teacher, for his suggestions will be needed and asked for many times during the week. But if he is a mere college or high-school graduate who has gained his knowledge of science from the lectures and experiments of the professor, he will find this work of making home-made apparatus even more beneficial to himself than it is to the pupils. He will by means of it have much light thrown upon obscure places, and will accordingly

teach more effectively. He will become so familiar with his work that he will find himself being transformed from a mere hearer of lessons from the book into an enthusiastic co-worker with his pupils.

WHY SO MANY DEFINITIONS OF RELIGION?

By FRANK N. RIALE, Ph. D.

RELIGION is now recognized, as never before, to be a universal factor in race development. "Whether we descend into the lowest roots of our intellectual growth, or ascend to the loftiest heights of modern speculation, everywhere we find religion a power that conquers even those who think they have conquered it." This fact is to the scientific student of religious thought what the "*cogito ergo sum*" was to Descartes, and what "justification by faith" was to Luther—the foundation on which all must rest, and the unquestioned presupposition from which he must start. It is certainly the fact that can not be doubted, and the one which no *aqua regia* of thought will dissolve.

But there are about as many definitions of religion as there are forms of religious belief. Herbert Spencer defines it as "an *a priori* theory of the universe." Matthew Arnold says it is "ethics heightened and lit up by emotion; or, more simply stated, morality touched by emotion." Max Müller seemingly differs widely from both, and calls it "the sense of dependence on something or some one not ourselves"; while Schleiermacher carries the idea still further and says, "It is a feeling of *absolute* dependence on something which, though it determine us, we can in no sense determine." Feuerbach makes religion "a mere covetousness, which manifests itself in prayer, sacrifice, and faith." Strauss combines the elements brought out in the last two definitions, and describes it as a "combination of absolute dependence and covetousness." To Hegel, the great genius of German thought, "religion is perfect freedom, for it is nothing more nor less than the Divine Spirit becoming conscious of Himself through the finite spirit." Very similar to this are the definitions of Luthardt and Martineau. The former says, "Religion is the human mind standing in reverence and inspiration before the infinite energy of the universe, asking to be lifted up into it, opening itself to inspiration"; while the latter expresses nearly the same idea, though more tersely, "Religion is mere assent through the conscience to God." Mr. Andrew Lang says: "Religion may be defined as the conception of divine or at least superhuman powers, entertained by men in moments of gratitude, need, or distress; when, as Homer says, 'all folk yearn after the gods.'" Flint, in

his Theism, regards it as a "belief in some god or powers above on which we depend, and who are interested in us; together with the feelings and practices resulting from such belief." Somewhat like this, but more explicit, is Prof. Whitney's definition; "A belief in a supernatural being or beings, whose actions are seen in the works of creation, and of such relation on the part of man toward this being or beings as to prompt the believer to acts of propitiation and worship, and to the regulation of conduct." De Pressensé thinks "true religion has to do with the relation of the soul to God," and Prof. Palmer sums it all up as "the bond between the science of ethics and the science of theology."

Many more definitions might be given, but let these few suffice; for they are typical of some sixty or more that have been examined. One is at once led to ask, Why are there so many definitions of a fact that is so universally admitted to be as real as any fact in the realm of mind or heart? Although the definitions are many, they can not be said to be contradictory or antagonistic. When carefully examined, it will be found that they each describe what their respective authors, either from personal experience or observation, thought was the controlling element exhibited at the moment of religious awakening. They are many, simply because the element exhibited then is not the same with all, but varies most markedly with environment, temperament, and general intellectual advancement.

It is now admitted that the religious element, if it appears at all, is called forth while one is reflecting on his personal destiny. There is then born a conviction that our future existence is not unalterably fixed, as that of the stone and the brute, but depends largely on our will. We feel that *ideals* have a large part to play in determining our future condition, and we desire to select such material out of all our environment—yes, *ought* to select such—to weave as a woof into the web of hereditary tendency, as will make for us characters most nearly like unto the pattern given in our ideal. In brief, it may be said that the religious element of the life is called out the moment one earnestly asks the question, "What must I do to be saved"—reach my ideal? That it does ever appear at this moment seems now to be a necessary conclusion from psychical study, a most careful examination of the marked religious awakenings in our own and other religious systems, from a study of the world's great religious leaders, and last of all, by a study of the varying element in the historic changes of religious thought. More than simply an enumeration of these lines of evidence can not be here given. Admitting this to be a fact, the reason why there are so many definitions will at once be perfectly clear; for it will be found they each describe what

was thought to be the essential thing for the attainment of the great idea.

A brief examination of a few of the definitions just given will make this clear. When one of a pre-eminently scientific cast of mind comes, in self-reflection, to the moment of religious awakening, he at once desires to *know* more of self and environment, that he may act with greater certainty in determining his destiny. He feels destiny depends primarily on *knowledge*, and to him religion most naturally seems what it does to Herbert Spencer, "an *a priori* theory of the universe." To those who feel, *activity* based on knowledge is the all-important thing. Prof. Palmer's definition better expresses the essential element—"the connecting link between the science of ethics and the science of theology"—the former giving a knowledge of one's relation to his fellows, the latter of his relation to the gods, religion being the dynamic called forth by this twofold knowledge of personal duty. There are others, again, decidedly social in their make-up. Their chief delight is in pleasant mingling with their fellows. These, on becoming conscious that they are the molders of their own destiny, feel at once that their "salvation" depends largely on a "good-will to mankind," with the acts that result therefrom. All such can truly say, with Arnold, that their religious life is "ethics touched by emotion." There is another class in the social organism of a clinging, dependent disposition, always followers and never leaders in life. These generally become so overwhelmed at the thought of their own responsibility that they lose all confidence in their own ability to choose out their own way, and at once throw themselves helpless on "the powers that be." Fate, or God, or universe, or anything, they would sooner rely upon than their own judgment. To these religion is what Müller found it, "a feeling of dependence on some one or something not ourselves." Extreme cases are better described by Schleiermacher—"absolute dependence on something which determines us, but which we can in no sense determine" (affect).

In marked contrast to the cases already named there are those whose lives are a perfect quintessence of egoism and selfishness. To these religion is always a "mere covetousness, which manifests itself in prayers, sacrifices, and faith." All such make Feuerbach's creed theirs too, "Mann ist was er isst." A higher type of religion than has been thus far named is that which feels "there is a divinity within us that shapes our ends," and that we are all "sons of the Highest." Such care not for self alone, but ever desire to become more and more altruistic. They study the microcosm only to more fully understand its functional place in the macrocosm. These, upon the religious awakening, have the egoistic thoughts thrust aside like the drift-wood by the sea, feeling that

they are only a hindrance to the attainment of the God-consciousness. Hegel-like, they find that "religion is a perfect freedom, for it is nothing more or less than the Divine Spirit becoming conscious of itself through the finite spirit." They can also say, with Martineau, it is "the human mind standing in reverence and inspiration before the Infinite Energy of the universe, asking to be lifted into it," or "ascent through the conscience to God." Religion to them is the last step of the Leibnitz's monad coming into the consciousness of the divinity ever potentially present.

Besides the types of minds thus far studied, there is a large proportion of the race influenced almost entirely by what may be called personal influences—love, pity, sympathy, and the like. All these, upon becoming religious, at once bestow similar feelings on the gods, and imagine that these in turn bestow the same on them. This mode of religious awakening is almost a universal one in the earlier stages of race development. Many also feel, as Mr. Martineau says in his Study of Religion, that in some form or other this will be likewise the final and highest stage of religious growth. It is well described by both Profs. Flint and Whitney, as noted above, and is also implied in the terse expression of De Pressensé, "Religion is the relation of the soul to God."

Thus it will be seen that the various definitions of religion are but facets of a common precious truth, reflecting at different angles the light of a heart all aglow with the thought of personal responsibility in individual destiny. They vary at times so as to indicate almost generic differences, but they all describe facts having a common psychological cause and point to a single purpose. As the same sunlight that hardens the bricks in the cathedral walls also melts the waxen taper at the altar, so a reflection on personal destiny often calls forth in one a religious life entirely different from that in another; for the precise effect depends as much on surroundings and internal difference as on that which calls forth the religious life. These definitions are not found to be like the Ptolemaic planets, mere lawless wanderers, in the realm of religious thought, but have a common center, and are guided by a universal law.

MR. JOHN AITKEN'S later observations on the number of dust-particles in the atmosphere show that a very large proportion of the pollution caused thereby is the product of human agencies. Both dust and humidity tend to decrease the transparency of the air. Humidity alone seems to have no influence on the transparency apart from the dust, but it increases the effect of dust by increasing the size of the particles. Its modifying effect is influenced by the temperature. Dust appears to condense vapor long before the air is cooled to the dew-point. Haze is shown in many cases to be simply dust, on which there seems to be always more or less moisture. All the fogs tested contained much dust.

THE MUSICAL SENSE IN ANIMALS AND MEN.*

By AUGUST WEISMANN.

THE author, having argued at length that the development of the musical sense is not a result of sexual selection; that it is not a faculty essential to the preservation of the race; and that, as it exists naturally in individuals previous to being cultivated, it is not a faculty that grows with the growth of the race—seeks an explanation of its existence in regarding it as simply a by-product of our organs of hearing. These organs, he goes on to say, are necessary in the struggle for existence, and may therefore have originated and been developed to a high degree in the process of selection. No one can be made to believe that the hand of man was formed with reference to playing the piano. It is adapted to grasping and to delicate touch; and, since these faculties are of great use in the struggle for existence, there was nothing in the way of making a finer fashioning of the hand already present in animals, agreeable with that process. In this way it has become finely fingered, delicate, and flexible as we know it, and as we find it even in the lowest savages. We can do with this hand a great many things that were not contemplated—if we may be permitted the expression—in its structure; among others, play the piano, that instrument having been invented; and a wild African, if we drill him to it from childhood, can, under the conditions of modern piano technics, learn it as well as a civilized child. The same is the case, I believe, to a considerable degree, in the artistic musical sense. That is, in a certain sense, a hand with which we play on the soul, but a hand that was not originally designed for that purpose—that is, did not originate out of the necessity of our discovering music, but out of entirely different necessities. This assertion is in need of a fuller demonstration. Our musical faculties consist of two parts: one, the organs of hearing proper—the outer, middle, and inner ear, which translate the different tones into nerve-movements; and the second, of the brain part, which converts these nerve-movements, when they have passed through the auditory nerve, into tone-perceptions, and the auditory center of the brain.

The first part of this duality—the organ of hearing proper—is not, so far as we know, much more highly developed in man than in many animals; and is not in other ways so constructed that we can conclude that it contains any different capacity from that of those animals for hearing music. The higher animals can also enjoy music, as my house-cat shows, when she comes at the play-

* From an article in the Deutsche Rundschau.

ing of the piano to sit by the player, and sometimes jumps into her lap or on the key-board of the instrument. I know of a dog, too, in a family in Berlin, which comes in in like manner when there is music, often from distant rooms, opening the door with his paw. I knew of another dog, usually thoroughly domestic, which occasionally played the vagabond for love of music. Whenever the semi-annual mass was celebrated in the city he could not be kept at the house. As soon as the so-called *Bergknappen*, which were accustomed to play at this time in the streets, appeared, he would run away and follow them from morning till evening.

Evidently neither cats nor dogs, nor other animals that listen to human music, were constituted for the appreciation of it, for it is not of the slightest use to them in the struggle for existence. Moreover, they and their organs of hearing were much older than man and his music. Their power of appreciating music is therefore an uncontemplated side-faculty of a hearing apparatus which has become on other grounds what we find it to be. So it is, I believe, with man. He has not acquired his musical hearing as such, but has received a highly developed organ of hearing by a process of selection, because it was necessary to him in the selective process; and this organ of hearing happens also to be adapted to listening to music.

It can not be said that this has been produced in man by natural breeding, or that it may not have been formed previous to the human period. We know nothing of our direct predecessors; and, even if their remains should be found, the bony parts of the organs of hearing in their skulls would furnish no clew to the microscopic particulars of the soft parts with which they were covered during life. It is, however, most probable that the precursors of man had nearly the same organs that he has now; for the living caricatures of men, the apes, have them in nearly the same perfection. We have a right to assume this, although we have not such detailed examinations of these organs as Hasse and Retzius have given us of similar organs in other mammals. We can not determine whether the compass of the scale audible to apes is quite as large as that of men; but we are authorized to presume that it is about the same. The power of perceiving the intervals between musical tones depends on a complicated apparatus in the coil of the ear. This apparatus, called, after its discoverer, the organ of Corti, includes thousands of nervous hair-cells, each of which is excitable only by a single tone of definite pitch. The delicacy of one's auditory apparatus—the correctness of Helmholtz's interpretation of the significance of these organs being presupposed—depends on the number of these hair-cells. According to the exact measurements and enumerations of Retzius, there are 15,500 of them in the ear of man, 12,500 in that of

the cat, and 7,800 in that of the rabbit. Hence man has a more perfect hearing than those animals, although we are not able yet to determine whether his superiority consists in finer delicacy or greater compass; possibly in both. There are also differences, but probably not of great extent, in the number of auditory cells between men; and we can explain by these differences why some persons can hear more sharply, or lower tones or higher tones, than others. I myself have a passably fine musical ear, but I can not hear the high tones in which certain species of grasshoppers make music, though hundreds of them may be "fiddling" at the same time, and although other persons recognize them without difficulty.

The question now arises how, if only useful qualities become established, this property of perceiving musical tones, possessed by rabbits and cats in substantially nearly the same degree with man, originated. It must be a matter of indifference to these animals, which do not make music, whether they have a musical sense or not, and the development of their hearing apparatus must have gone on with reference to other needs of theirs. What were those needs? In what respect is it useful to animals to have the power of perceiving so great a number of distinct tones as are provided for in their hearing apparatus? The question has never been discussed, and I confess that the answer is not easy, if a full and detailed explanation is sought. But in a general sense the reason seems easily comprehensible. Wild animals need a very fine ear—beasts of prey, like cats, in order that they may hear and distinguish all the tones that are emitted by their game. A considerable scale is at once in demand for this; one, for example, which shall enable the wild cat to distinguish the cooing of the dove, the call of the cuckoo through all its tones, and those of the thrush, finch, linnet, pheasant, and the other birds and little animals of the wood and field. The wild animal must also be able to distinguish the sounds of his enemies—whether it be the intended victim having to escape his pursuer, or the beast of prey avoiding a rival; to the list of which, already large, has been added man, who appeared after animals' organs of hearing were fully developed. For this purpose the hearing of these animals should be capable of perceiving low tones and high tones, and the complete series of tones between. A feeling of wonder comes over us when we see how highly developed the hearing of animals is, and we can hardly comprehend it except we consider to what an extent their existence in the wild condition depends upon an extreme delicacy of the organ. There must be no uncertainty in their minds as to the kind of source whence any sound comes. A mistake may be a matter of life and death to them. The food of a beast of prey is precarious, and he can not afford to let any

opportunity of supplying himself pass. It is not for nothing that the fox watches night and day intent to take notice of the lightest movement in the air; or that the hare is a proverbially timid beast, for the existence of his species depends upon his being on the alert. We can thus understand to a certain extent why the rabbit has 7,800 auditory cells in his organ; a number that represents a wonderfully delicate refinement in his hearing, even if we do not suppose each of these 7,800 cells to correspond with a different tone, as, if we regard each cross-shaped group of four cells as representing a single tone, this would give an exceedingly large number—about two thousand—of tone-perceptions. We may realize how delicate must be the hearing that appreciates even a thousand tones when we recollect that our concert-piano scales give only eighty-seven tones. Even if we take a scale of greater compass, as of a hundred tones at intervals of a semitone, our rabbit will have capacity to distinguish nineteen intertones in each half-tone interval. We, ourselves, if we exercise our full power of hearing, could distinguish some thirty intertones between the tones A and B♭ of our scale—a few more than the difference in the number of vibrations corresponding with those notes (A=440, B♭=467·5).

To make this highly developed organization of the ear of real benefit to the animal, the parts of the brain corresponding with the auditory nerves must be constituted with like delicacy. So also must those parts which serve for the remembrance of sensations. For, without memory and the power to profit by the lessons of experience, those powers would be of little use to the animal.

It is only in a few instances that we can ascertain with any degree of sufficiency how far an animal is capable of really comprehending our music. The capacity often appears to be considerable; for it is well known that cavalry-horses frequently learn to recognize the signals given by the trumpeters as well as their riders do, and to make the motions answering to them before they are directed to do so. We have, furthermore, in many birds, which are far below the mammals we have named in mental capacity, good evidence that our music can be heard and comprehended by beings whose hearing apparatus has not been adapted to those ends. I refer especially to birds which have no or only very simple songs of their own, and are yet able to imitate both the more varied songs of other birds and human melodies. This is conspicuously the case with some of the parrots, which can learn to repeat short melodies well and distinctly. They also possess the proper organs for hearing music, although they do not themselves make it. Thus our proposition seems well founded that, as man possessed musical hearing organs before he made music, those

organs did not reach their present high development through practice in music.

Among the objections that may be brought up against this theory, the most real is that founded on the existence of persons without musical sense; who can hear ordinary sounds and intonations as well as musically gifted persons, but who can not define musical intervals, can not take up a melody and repeat it, and can not analyze harmonies. If their organs of hearing are as well developed as those of musicians, that would seem to be evidence that the musical sense is something else than ordinary hearing, and supplementary to it. But it has not been demonstrated that the hearing of unmusical persons is as well developed as that of musicians, and I regard it as highly improbable. Although we have no accurate data on the subject, the facts we have do not sustain the proposition. The idea of unmusicality is a relative one. Mozart had so wonderful a recollection of tone-pitches that he could detect a difference of a quarter of a tone between a violin he was playing and one which he had played on two days before. Other men, whom we regard as men of high musical talent, have only the weakest, or no memory at all, for absolute tone-pitches. They can not tell whether a piece is played in A, C, or F, but are satisfied if the tone-intervals within the piece are properly represented. Defects of this kind are corollaries of want of practice, and result to a large extent from the considerable part which the piano fills in musical teaching. The sense of players on the violin —an instrument on which minute intervals of tone can be produced—is much clearer and more delicate than that of players on the piano. The various degrees of defect in musical sense seem to me to depend on a more or less imperfect structure of the organs of hearing. Defects and aberrations appear in all parts of the body, and must be particularly apt to overtake an organ which, like the ear of man, is now no longer of the importance for maintaining the species which it must have been several thousand years ago when man was still in a state of nature. Or there may be defects in the brain-centers that receive the nervous impressions, or in the connections between the brain and nerves. Light is cast upon these instances through the accounts of cases of aphasia and musical impotency, in which, through injury to a small spot in the brain, the faculty of appreciating or producing music is partly or wholly removed, usually in connection with disorders of speech. Besides the older observations of Kussmaul, Kast, Knoblauch, and Oppenheim have made interesting contributions on this difficult and complicated subject.

Have we a right to suppose that the musical gifts of the primitive man were the same as we have to-day? Can we imagine that men were born in the earliest ages who might have furnished a

Haydn, Mozart, or Beethoven, or have acquired even the average musical skill of our day? I do not believe it; for something else is needed for the comprehension of our present higher music than the musical apparatus of our ear and brain-center, and more than the musical instruction that can be given in one person's lifetime —a refined, impressionable, cultivated soul.

The auditory center of the brain often spoken of is not simply theoretical, but is defined with fair certainty. If, in a dog or an ape, a particular spot in the temporal fold of the cerebrum is destroyed on both sides, the animal will be made deaf, although his ear-organs have not been disturbed. The animal's general health is not impaired; it continues to live, but it ceases to hear. Noises passing through its hearing apparatus still excite nervous vibrations, and these are still transmitted to the brain; but the organ is lacking there which should convert them into tone-perceptions and bring them to consciousness. The animal is "soul-deaf." If, again, we were able to remove all the other parts of the cerebellum and leave the hearing centers untouched, the mechanical process of the production of tone impressions would still go on, but the animal or the man would hear nothing, because there would be nothing left in his brain to make him conscious of the tone-impressions. With the rest of the cerebellum was taken away the intellect, with all its side-faculties of feeling, fancy, self-consciousness, etc. The "soul" is wanting, and without it the finest musical notes, brought to place in the hearing center, make no impression.

I have brought forward this hypothetical case to show that the way in which music is comprehended depends not only on the auditory centers, but as much on that which lies behind them, which takes up the tone-images formed by them and gives them reality—the "soul." If there is no "soul,"-as in the supposed case, then the tone-images are not perceived; if a highly developed, tuneful, and thoughtful human soul is present, then the confluent and contrasted voices of a polyphone music are perceived as a charming musical structure, a rich art-picture, the single parts of which stand in perceptible connection; going out from one another, running back into one another, the individual tone-pictures shape themselves by ever new variations into ever new and interesting combinations. But if there is only the relatively lowly organized brain of an animal, a parrot, for instance, then the spiritual power of the complicated tone-picture will not prevail, and only a possibly pleasant confusion of sounds is perceived. The parrot will never be able to follow the course of a piece of music, because he lacks the necessary degree of intelligence, but will only be able to repeat snatches of it, with no comprehension of the connection of the parts. Hence we conclude that affections

of the same organs of hearing and of the auditory centers appertaining to them must produce different effects on the "soul" according to its degree of development. The "soul" is in a manner played upon by the musical movements of the auditory centers as if it was an instrument; the more complete the instrument, the greater the effect. Hence the comprehension of our music by the highest animals—the dog, the cat, and the horse—is exceedingly imperfect, because of their limited mental development. Music strikes them as pleasant or unpleasant, or attracts them, independently of what we call the character of the piece. The same differences, except in a lesser degree, must prevail in the different stages of development of the human soul. If the primitive man did not have a mind equal to ours; if man's intellect and all that depends upon it has been growing sharper and more profound during the thousands of years of his struggle for existence, his faculty for comprehending music must also have been enlarged in the course of time. For this reason we can not suppose that any Beethovens were concealed among primitive men, or are running around among contemporary Australians or negroes. For that is needed, not only a strongly cultivated musical sense, but also a rich, great, deeply emotional soul such as accompanies an intellect schooled according to the sum of its experiences. I will go further, and say that I do not believe that a child of one of these primitive men, if he were given to us to-day, could be trained to the same degree of musical appreciation as our children are capable of. The native higher mental faculties would be wanting in him. While savages are lower in mental development than civilized man, and while we recognize that man's receptivity for music has grown with his mental development, we must doubt if any increase in the power of the human mind has taken place in historical times. The civilized natives of antiquity appear to have already reached a very high degree of mental capacity; and their lawgivers, poets, philosophers, architects, and sculptors have had no successors superior to them. We have a right to suppose also that the ancients had the same musical sense and talent for music as we; and that, if their music was inferior, it was not for lack in that direction, but for the want of the products of the continued exercise of the musical talent—of invention and discovery—acquired and transmitted from generation to generation, and added to, by the aid of which we have reached our high degree of cultivation. Although man's physical power may not increase, we have a right to expect an almost unlimited advance of mankind in mental cultivation, by each generation building upon the stage which its predecessor had reached, and thus continuing perpetually to go higher.

HUMAN HEREDITY.

By JAMES H. STOLLER,
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IN common speech we use the term heredity as signifying simply that principle by which the qualities of parents are transmitted to their children. We give the term a meaning broad enough to cover facts which come within our ordinary notice. We see that the features of children—the shape of the brow and nose, the color of the hair and eyes—bear a resemblance to those of the parents; as they grow older we notice not only physical but also psychical resemblances—the temperament, tastes, and aptitudes are more or less like those of the parents. We find an explanation of these likenesses in the principle of heredity; and, as no evidence of any deeper operation of such a principle comes within our ordinary observation, we limit it to these particulars. It is true that occasionally we are reminded that the principle may extend to a second generation; we see the traits of the grandparent reappearing in the child, this being most noticeably true in respect to certain bodily disorders, as scrofulous diseases and certain forms of insanity. But we seldom think that the principle of heredity operates through more than the two or three generations of our immediate ancestors, or that any other qualities than those which are specifically peculiar to us—that mark our individuality of body or mind—come to us by it.

A little reflection, however, must convince us that this principle works more deeply. Those qualities that distinguish us as members of a nationality—whence come they? As Americans we pride ourselves that there is something distinctive about us, that places us in a different category from Englishmen and Frenchmen. Whence come these national characteristics? They were possessed by our fathers and our grandfathers, and the immediate inference, therefore, is that they come to us by inheritance. Of course, we have to consider that the fathers who were the founders of the nation did not inherit the American characteristics, since we must regard them as the original possessors of them. The fact seems to be that national characteristics originate in external causes, but once established they are perpetuated by inheritance. It may be urged, of course, that external causes operate upon succeeding generations as well as the antecedent one, as evidenced in our nationality by its rapid absorption of foreign stock. No doubt the direct influence of our institutions is a constant force in the development of the national characteristics, and goes a great way toward Americanizing citizens of foreign birth even in a single generation. But to native-born Ameri-

cans this influence simply adds itself to that of inheritance, and does not diminish its strength or importance. Taking a general view of the question, the case becomes very obvious. It will scarcely be disputed that national characteristics manifest themselves definitely, not only in the temperament, ideas, etc., of the people, but also in their bodily features. We speak of the English type of facial features, the German type, etc., and every one appreciates that these terms express real distinctions. Moreover, we know that these types have existed a long time, slightly variable, no doubt, but never losing the main lines. It is scarcely necessary to say that this continuance of type rests on heredity. The case is precisely the same as that of the continuance of the family likeness, only the family is larger and the features less distinctive, though, in the long run, they are more faithfully conserved.

Lying deeper than those characteristics that mark us as members of a nationality are others that mark us as members of one of the great races of the human family. The term race has different significations according to its use, whether referring to distinctions chiefly of an anatomical character (though connoting others), as the Caucasian, Mongolian, etc., races, or to distinctions based more directly on differences of lineage, as the Celtic, Teutonic, etc., races. For the purpose in hand we use it in the former sense, dividing mankind into the usual five races, Caucasian, negro, Indian, etc. Now, it is obvious that our race characteristics come to us in the same way as our national and family characteristics: we get our white skin and orthognathous skulls by inheritance just as truly as our more specific bodily features, only these qualities come to us from ancestors more remote. We need not concern ourselves here how they obtained them, nor whether they were acquired suddenly in a single generation or gradually through many generations. The point to be insisted upon is that, race characteristics once established, they are transmitted by inheritance through all succeeding generations. Of course, the principle applies not only to merely anatomical features, but to mental traits as well. The peculiarities of mental constitution that make the Caucasian the most progressive race are handed down by inheritance just as truly as the color of the skin and the shape of the skull.

Still deeper than the race characteristics—more fundamental than they—are those that mark us as members of the human family itself. Our convoluted brains, our power of verbal speech, certain of our intellectual and our moral faculties, these are the qualities that belong to us in common with all men, and that distinguish us from the highest animals. Whence came these qualities? It can only be answered that they came from the

fathers of the race, having been transmitted by the law of heredity through the successive generations to us. It matters not whether the race originated in a single pair or had a multiplex origin, nor are we here concerned how our progenitors came to possess these qualities at all; the fact at hand is that, once having lived, they transmitted to their descendants down to us their distinctive human qualities.

The facts to which our attention has now been given are summarized as follows:

All the qualities of our human nature come to us by inheritance.

Those qualities which are strictly individual—the "skin-deep" qualities—come to us from our immediate ancestors, our parents and grandparents.

Those qualities which are less specific, which we have in common with others who live under the same laws and institutions, and generally under similar physical conditions, come to us from ancestors more remote, though quite within historic time.

Those qualities which are still more general, which we have in common with others of the same general physical features, came from ancestors much more remote, whose records are lost in prehistoric time.

Those qualities which are broadly anthropological, which we possess in common with all members of the human family, came to us from the original progenitors of the race.

We have thus far considered only the strictly human qualities of our nature. We have now to consider whether the operation of the law of heredity extends also to the animal qualities. Let us first notice those which man possesses in common with the highest animals. They are, a vertebral column, giving form and flexibility to the body; two pairs of limbs for prehension and locomotion, mammary glands supplying food for the young; a four-chambered heart and double blood-circulation; and, finally, a well-developed nervous system, with sense-organs, placing the animal in conscious relation with the external world. Does the principle of heredity by which, as we have seen, all our anthropological qualities have come to us, give us also these zoölogical qualities? The point here to be enforced is, that if the answer to this question is not in the affirmative, then there is a break in that law, the operation of which we have seen to extend from the most specific to the most general anthropological qualities. In considering whether there is such a break, the special point of inquiry is whether the two classes of qualities, the anthropological and the zoölogical, are different from each other in kind. For, if they be the same in kind, the presumption is that the law operates in respect to both; in other words, that there is no break. The an-

thropological qualities are, as we have seen, partly physical—the shape of the skull, the structure of the brain, the color of the skin—and partly psychical, the intellectual and moral faculties. The zoölogical qualities are also partly physical and partly psychical: of the former class, the general structure of the body and the particular structure of organs, as the heart, lungs, glands, etc.; of the latter class, the faculties of intelligence. It appears, therefore, that the zoölogical qualities are the same in kind with the anthropological, and the inference, therefore, is that the law of heredity extends also to them. That is to say, as we proceed, step by step, from the most specific to the most general qualities peculiar to man, and then by the next step pass to those qualities which we possess in common with the highest animals, we find that the last term of the series is the same in kind with the others, and all the reasons that lead us to conclude that the law of heredity extends successively through the first terms of the series lead us to conclude that it extends also to the last.

The fact that not all the anthropological qualities have their zoölogical prototypes does not at all affect the force of the inference. We may allow, for example, that the moral faculties are strictly anthropological; but this does not detract from the evidence that the intellectual faculties came from the zoölogical prototypes, any more than the fact that the Italian people have dark complexions detracts from the evidence that they descended from Caucasian progenitors. In other words, the possession of specific qualities by a class—qualities not received by inheritance—affects in no way the evidence that the general qualities of the class were received by inheritance. We have recognized this principle at each step in the present discussion. For example, we saw that the national characteristics of a people arise from other causes than inheritance, but this did not lead us to conclude that the race characteristics of the same people were not inherited. In fact, every person affords in his own facial features an illustration of this principle. The expression of our countenances, whether intelligent or dull, cheerful or grave, etc., has been determined by the circumstances of our lives—education, etc.; but the anatomical features—color of eyes, shape of nose, etc.—are inherited from our parents.

Our conclusion, therefore, is that the evidences that man has inherited his anthropological qualities apply equally as well to his having inherited his zoölogical qualities.

Below those qualities which man has in common with the higher animals are others which he possesses in common with the lower animals also. These are chiefly anatomical and physiological in character, such as the possession of bodies whose structural units consist of cells, organs which perform the functions of ali-

mentation, reproduction, etc. The reasoning already employed leads us to conclude that these lower animals were the ancestors of the higher, and transmitted to them the qualities which the two classes possess in common. For example, both the higher and lower animals possess an alimentary canal—a tube running through the body for the reception and digestion of food. We conclude that this alimentary canal was not obtained by the higher animals through external causes, but by inheritance from the lower animals.

We have, finally, to consider those qualities which man, and both the higher and lower grades of animals, possess in common with the very lowest animals. These lowest animals, consisting in respect to their physical characters simply of minute jelly-particles, destitute of organization, agree with the higher animals only in their physiological properties. These are essentially only two, nutrition and reproduction. These, indeed, are the two absolutely fundamental and essential properties of any living organism. Without the one, the life of the individual ceases; without the other, the life of the species. From the biological point of view, the carrying out of these two functions of nutrition and reproduction is the sole end of existence of any living being. Animals differ from one another—they occupy a lower or higher place in the scale of life—according to the advantages of organization enabling them to carry out these functions. The special powers possessed by animals which at first sight seemed to be ends in themselves, are seen by a moment's reflection to be only subservient to these two great ends. In birds, for example, both those powers depending upon structural perfection, as flight, vision, song, and plumage, and those depending upon a highly developed nervous system, as the instincts of migration and nest-building, serve, in the end, wholly to better enable the animals to maintain their own life and that of their species—to carry out the functions of nutrition and reproduction. Thus, rapid flight and keen vision enable them to procure food; melodious notes and brilliant plumage are sexual attractions; while migration and nest-building are directly connected with nutrition and reproduction respectively. From these considerations it is seen that, to the biologist, the simplest animals—the animate jelly-particles—are beings of far higher rank than their physical simplicity would indicate, since they carry on the same life-processes that other animals do, only lacking parts and organs subserving the operation of these processes. It is, therefore, only to assume that like proceeds from like to suppose that from these simplest animals the higher forms received by the law of heredity the two powers of their being which all possess in common—nutrition and reproduction. The differences subsisting between these lowest animals and the higher

are not differences relating to the life-characters, but merely to the physical forms in which life manifests itself.

As we know of no simpler organisms than these, and can not conceive that life could manifest itself in any simpler forms, we must regard them as the primordial animals—the progenitors of the animal kingdom.

The conclusion which we reach, then, is that not only all man's distinctively human qualities came to him by inheritance, but also all his purely animal qualities. The former came from human ancestors, the latter from animal ancestors. And as with the former, so with the latter; the more specific came from ancestors less remote, the more general from ancestors more remote. The most general, the absolutely fundamental and essential, came from the primordial living beings.

The animals of the first life-period were succeeded by others which, as we have seen, possessed not only the physiological characters of the primordial organisms, but also certain anatomical characters not received by inheritance, enabling them to carry out the physiological processes more perfectly. If for the sake of simplicity we consider the animals of the first and second life-periods to be those which we have already designated as the lowest and the lower animals respectively, then the latter received by inheritance from the former their functions of nutrition and reproduction, and acquired the special organs of alimentation and reproduction by which these functions were the better carried on. The question whence these new characters came need form no part of our present inquiry. For our purpose it will be sufficient to say that they resulted from external causes, it being understood that it is not intended to preclude the idea of the agencies in question being natural causes. The fact here to be set forth is that these animals of the second life-period transmitted, by the law of heredity, these characters that first appeared in them, along with those which they had received by inheritance, to their descendants. It is not to be supposed, of course, that the characters were preserved unmodified as to details, but only that their general nature, both as to structure and use, were retained. The animals of the third life-period—which we may consider those we have called the higher animals—therefore possessed at the outset all the characters of the first, together with those that were peculiar to the second. They, in their turn, under the influence of external causes, came to possess new characters—a vertebral column, four-chambered heart, etc.—while those which they had received by inheritance from their forerunners of the second period attained in them a higher development; in their turn, too, they transmitted their advanced organization to the succeeding order of beings—that is, to the human race. This

same process continued through the successive generations of the human family. The distinctively human qualities acquired at the outset, together with the accumulation of inherited animal qualities, were handed down to the races that succeeded. They, in turn, bestowed all that had been bequeathed to them, together with their newly acquired race characteristics, to their descendants. Finally, the national characteristics, which in our time we may suppose to include all the traits that characterize civilized man, were differentiated.

Civilized man, therefore, inherits the accumulation of benefits that have come from the operation of the law of heredity through the long ages since life began upon the earth. In a deeper sense than we commonly think, we are the heirs of all the ages.

Man does not come into his full inheritance at the beginning of his existence. It is a fact of exceeding significance that, at the beginning of embryonic life, our bodies consist of nothing more than a single cell, precisely similar to the minute organisms with which life began upon the earth. It is as if man acknowledged the debt which he owes to these primordial living beings. But it is not only to the primal form of life that he makes this confession of affinity; for, as is well known, the successive stages of embryonic development represent the succession of type forms of animal life as they appeared upon the earth. Thus, man comes into his inheritance by degrees. At the beginning of his existence he possesses the characters of the primal forms of life; a little later, those of the second life-period—such as belong to the lower animals; still later, those of the third life-period—such as belong to the higher grade of animals. At a considerable time before birth he has already come into possession of all the animal qualities, and at birth the human physical characters are present. Then follows a more perfect development of the physical characters, and at the same time the acquirement of the higher human characteristics—the power of speech and the mental and moral faculties. Thus, in the unfolding embryo and in the growing child we have recorded in dim but unmistakable characters the history of the life of the earth.

A suggestion, looking to the future, here presents itself. The same agencies out of which has come the progress of the past are in operation now. It is, therefore, only in the course of nature that there should be a further progress. And as respects man, according to a law that has governed in the past, namely, that the most recently acquired characters of a type are most subject to progressive change, we may expect that advancement will be chiefly in respect to his higher powers—his intellectual, moral, and spiritual nature.

A TALK ABOUT METEORITES.

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METEORITES are particularly interesting because they comprise the only material coming to us from outer space. In consequence of the striking phenomena resulting from their rapid passage through our atmosphere, making them appear like balls of fire visible at great distances, sometimes exploding with such violence as to be taken for earthquakes, their falls have been noticed and recorded since the earliest times. The accounts, however, were so imbued with superstitions, and so distorted by the terrified condition of the narrators, that in most cases the witnesses of the event were laughed at for their supposed delusions, and it was not till the beginning of the present century that men of science and people in general began to give credit to such reports.

The earliest authentic records of stones falling from the sky are to be found in the Chinese annals, which go back to 644 B. C., and between that time and 333 A. D. Biot has traced sixteen distinct occurrences. In Europe, a meteorite is said to have fallen in Crete as far back as 1478 B. C., but Greek history can not be depended upon for events earlier than 700 B. C. A more probable fall, in 705 B. C., is mentioned by Plutarch; while Livy, in his History of Rome, gives an account of a shower of stones which fell on the Alban Mount about 652 B. C., and which so impressed the senate that they decreed a nine days' solemn festival. Again, in 466 B. C., a stone fell at Ægospotamos, in Thrace, which is mentioned in the Parian Marbles, and also by Plutarch and Pliny, which is said to have been of the size of two millstones, and equal in weight to a full wagon-load. Still more famous was the meteorite which fell 204 B. C. in Phrygia, described as conical in shape, of a deep-brown color, and looking like a piece of lava, and so pointed at the top that it was called the "needle" of Cybele. This stone was believed to have fallen from heaven, and was worshiped at Pessinus by the Phrygians and Phœnicians as the Great Mother of the Gods. At the time of the second Punic war, upon the announcement by an oracle that its possession would secure continued prosperity to the state, it was demanded from King Attalus and taken with great ceremony to Rome, where it was mounted on a silver statue of the goddess in place of the head. Signor Lanciani has traced its existence down to 1730. It was then finally lost sight of, but he thinks it may still exist, buried in the ruins of the Palace of the Cæsars. The Diana of the Ephesians, "which fell down from Jupiter," and

the Image of Venus at Cyprus, are now considered to have been similar meteoric masses.

There is a stone whose history goes back at least twelve centuries, built into the northeast corner of the Kaaba at Mecca, held in great reverence by the Moslems, which is supposed to have had a similar origin.

There are also numerous accounts of meteorites having been worshiped in more modern times. One which fell about one hundred and fifty years ago was worshiped for some time in the temple of Ogi in Japan; and a stone which fell in a field near the village of Dooralla, in India, in 1815, was immediately decked with flowers, and the natives would have built a temple over it were it not for a powerful constraint which took it to the British Museum.

Undoubtedly the oldest meteorite still preserved is one now in the Harvard collection, which was found by Prof. Putnam on the altar of Mound No. 4 of the Turner Group (Little Miami Valley, Ohio). It possibly had been an object of worship to the old mound-builders during some prehistoric age, and the worship of such sky-stones is considered by many writers to have been the oldest form of idolatry. It is well known, however, that meteoric iron was used by the mound-builders for coating bronze ornaments with a white metal; and two meteoric fragments, consisting wholly of iron, were found on a neighboring altar. Many such ornaments are to be found in our museums. There is an account in Dio Cassius of an attempt, under the Emperor Severus, to coat bronze coins with silver which was said to have come down from heaven. The same mistake of taking meteoric iron for silver is frequently made in the present day, owing to an unusual whiteness of the iron and its extreme malleability.

The oldest undoubted meteorite seen to fall was, till recently, suspended by a chain from the vault of the parish church of Ensisheim, in Alsace. The following, translated from a document still preserved in the church, gives an account of its fall:

"On the 16th of November, 1492, a singular miracle happened; for, between eleven and twelve in the forenoon, with a loud crash of thunder and a prolonged noise heard afar off, there fell in the town of Ensisheim a stone weighing two hundred pounds. It was seen by a child to strike the ground in a field near the canton called Gisgaud, where it made a hole more than five feet deep. It was taken to the church as being a miraculous object. The noise was heard so distinctly at Lucerne Villing and many other places that in each of them it was thought some houses had fallen. King Maximilian, who was then at Ensisheim, had the stone carried to the castle; after breaking off two pieces, one for the Duke Sigismund of Austria and the other for himself, he forbade fur-

ther damage, and ordered the stone to be suspended in the parish church."

In 1768 a stone was seen to fall at Lucé, in France, and three French Academicians, one of whom was Lavoisier, were appointed to investigate it. As they were convinced beforehand that the stone could not have fallen from the sky, they reported to the Academy that it was an ordinary stone, which had been struck by lightning.

The German philosopher Chladni, in 1794, was the first to bring together the accounts of bodies said to have fallen from the sky, and he felt confident in his conclusion that at least two of these came from outer space. One was the now well-known Pallas meteorite, found by a Cossack, in 1749, on the top of a lofty mountain, and brought by the traveler Pallas from Krasnojarsk, Siberia, in 1772. The mass, consisting largely of iron, weighed fifteen hundred pounds, and was thought by the Tartars to be a holy thing fallen from heaven, because it differed entirely from all the rocks of the country. The second was one found, in 1783, by Indians, projecting a foot above the ground, at Otumpa, province of Tucuman, Argentine Republic. It was thought to be an iron-mine, and Don Michael Rubin de Celis was sent to investigate it. He reported that it was a mass of iron weighing about thirty thousand pounds, and that there was no other iron in the neighborhood, and no stones, and no human habitations.

Chladni argued that these two masses of iron must have been formed through fire, and, as there were no signs of volcanoes in the countries where they were found, and as volcanoes had never been known to eject masses of iron, he concluded that they must have come to our earth from space.

Two months after Chladni had advanced his theory, there fell a shower of stones at Siena, in Tuscany, an account of which was given in a letter received by Sir William Hamilton from the Earl of Bristol, dated Siena, July 12, 1794:

"In the midst of a most violent thunder-storm, about a dozen stones of various weights and dimensions fell at the feet of different persons, men, women, and children. The stones are of a quality not found in any part of the Siennese territory: they fell about eighteen hours after the enormous eruption of Mount Vesuvius, which circumstance leaves a choice of difficulties in the solution of this extraordinary phenomenon. Either these stones have been generated in this igneous mass of clouds which produced such unusual thunder, or, which is equally incredible, they were thrown from Vesuvius at a distance of at least two hundred and fifty miles; judge, then, of its parabola. The philosophers here incline to the first solution. I wish much, sir, to know your sentiments. My first objection was to the fact itself, but of this there are so

many eye-witnesses it seems impossible to withstand their evidence."

As the wind was from the north when the stones fell at Siena, while Vesuvius was to the south, it was suggested that the cloud from which they came had been blown all the way from Vesuvius past Siena and then back again, before it condensed.

The next meteorite seen to fall was in England itself. On December 13, 1795, a stone weighing fifty-six pounds fell at Wold Cottage, in Yorkshire, at about three o'clock in the afternoon, and several persons saw it fall. It fell on a perfectly clear day, and penetrated twelve inches of soil and six inches of chalk rock. In the neighboring villages sounds were heard which were taken for the firing of guns at sea, and in two villages there was such a distinct sound of something whizzing through the air toward the house of a Mr. Topham that several people ran there to see what had happened. When the stone was dug up it was warm and smoked. It was exhibited in London, and handbills were distributed giving an account of its descent. Such advertising, however, did not tend to make people believe in the celestial origin of the stone; and, as there were no volcanoes in England, it was thought that it might have been condensed from a cloud of ashes blown from Mount Hecla in Iceland. We do not, however, have to go back one hundred years to find wild hypotheses as to the probable origin of meteorites. Even now very little is known, and the field for speculation is nearly as unlimited as it was then, though the theories of a few centuries ago are simpler and more amusing than the recent ones. In the chronicles of the Benedictine monks a theory of the origin of meteorites is given briefly thus:

"In the year 921, in the time of Lord John X, pope, in the seventh year of his pontificate, signs were seen; for, near the city of Rome, many stones were seen to fall from the sky—such dreadful and terrible ones in the city of Narnia that people had to believe that they were brought straight from hell. The very biggest of the stones, falling into the river Narnius, can be seen to this day, projecting a cubit above the surface of the water."

A Persian philosopher, Syed Abdulla, in 1814, describing a fall of stones near Bombay, says: "The causes of this may be, that in the course of working (or of changes on) the ground, air being extricated, may have entered into combination, and come near elemental fire, and from this fire have received a portion of heat; that then it may have united with brimstone and terrene salt, as, for instance, saltpeter; when the mixture, from some cause, being ignited, the fire bestows its own property on the mass, and the stones which may have been above it are blown into the air—God knows the truth."

In 1818 Dr. W. G. Reynolds, in offering a theory on meteorites, says: "Dr. Blagden considers electricity as the general cause of these phenomena; Dr. Gregory and others think they depend on highly inflammable matter, as phosphorus, phosphorated hydrogen, etc., being volatilized and congregated in the upper regions of the air. Dr. Halley ascribes them to a fortuitous concourse of atoms, which the earth meets in her annual track through the ecliptic; and Sir John Pringle seems to regard them as bodies of a celestial character, revolving around centers, and intended by the Creator for wise and beneficent purposes, perhaps to our atmosphere, to free it of noxious qualities, or supply such as are salutary." Dr. Reynolds then goes on to elaborate a most complicated theory in which solid substances on the earth are changed to vapor by the sun's heat; these, rising as gases, finally give up their heat by an explosion, and the particles, having no heat to keep them apart, rush together and come down as solids.

"While the minds of the scientific men of France were in this unsettled condition, there came a report that still another shower of stones had fallen, this time in their own country, and within easy reach of Paris. To settle the matter finally, if possible, the physicist Biot, member of the French Academy, was directed by the Minister of the Interior to inquire into the event upon the spot. After a careful examination of the stones and a comparison of the statements of the villagers, Biot was convinced that—

"1. On Tuesday, April 26, 1803, about 1 P. M., there was a violent *explosion* in the neighborhood of L'Aigle, in the department of Orne, lasting for five or six minutes; this was heard for a distance of seventy-five miles round.

"2. Some moments before the explosion at L'Aigle, a *fire-ball* in quick motion was seen from several of the adjoining towns, though not from L'Aigle itself.

"3. There was absolutely no doubt that on the same day many stones fell in the neighborhood of L'Aigle.

"Biot estimated the number of the stones at two or three thousand; they fell within an ellipse of which the larger axis was 6·2 miles, and the smaller 2·5 miles; and this inequality would indicate not a single explosion but a series of them. With the exception of a few little clouds of ordinary character, the sky was quite clear.

"The exhaustive report of Biot, and the conclusive nature of his proofs, compelled the whole of the scientific world to recognize the fall of stones on the earth from outer space as an undoubted fact."*

The main difficulty in forming theories at the present time is

* British Museum Catalogue of Meteorites.

due to the fact that there are two distinct classes of meteorites, irons and stones, the characteristics of which make it difficult to assign a like origin to both. It is probable, however, that they all belong to our solar system; that they are revolving round the sun in some different plane from the ecliptic, and that the earth is constantly meeting them in its yearly journey. When they come into contact with our atmosphere, although they are moving with planetary velocity—sometimes at the rate of forty-five miles a second, more than twice as fast as the earth moves in its orbit—their motion is rapidly reduced, owing to the resistance of the air, so that in most cases they come to the ground like a spent cannon-ball. Their passage through the air is only of a few seconds' duration, yet the rapid reduction of velocity determines a great heating effect, so that the meteorite, a moment before intensely cold, is immediately fused on the surface, forming a coating varying from a fiftieth to a hundredth of an inch in thickness, and this crust is one of the first characteristics by which a meteorite is recognized. Moreover, the material burns away unevenly, forming pittings or thumb-marks, resembling the marks left by the fingers on a mass of putty—a character also observed on large grains of partially burned powder picked up after the discharge of large guns. The meteorite from Cynthiana, Ky., in the Harvard collection, shows similar marks though more in furrows, made by a flow of the melted surface from the front to the back of the mass during its passage.

The unequal heating of meteorites by the atmosphere causes pieces to crack off, and sometimes the whole mass explodes. In addition, the air rushing in to fill the space behind the rapidly moving body, causes a sound variously compared to claps of thunder, firing of musketry, the tearing of calico, and the like—a noise frequently heard after the passage of the meteorite, owing to the circumstance that the sound travels so much more slowly than the mass itself. Furthermore, the high temperature of the surface causes the mass to glow with a brilliant light, making it appear like a ball of fire, and visible at distances depending on its height above the horizon, sometimes over an area of one thousand miles. Thus a meteorite was seen in 1876 to pass over the States of Kansas, Nebraska, Iowa, Missouri, Wisconsin, Illinois, Michigan, Kentucky, Indiana, Ohio, West Virginia, and Pennsylvania; and explosions were heard like cannonading even to the distance of one hundred and fifty miles from its course. Over Illinois it was seen to break in pieces like a rocket, and over Indiana and Ohio the pieces were computed to cover an area forty miles long and five miles broad. At Rochester, Fulton County, Indiana, during the meteorite's passage, a farmer heard the thud of something striking the ground near his house, and in the morning found a

fragment of rock on top of the snow, which is supposed to be part of the meteorite.

All meteorites appear to be fragments broken off from larger bodies. Sometimes numerous fragments reach the earth, and at other times only single masses. Thus, in the fall at L'Aigle, already mentioned, about three thousand pieces were picked up, scattered over an ellipse more than six miles long. An equally large number fell at Knyahinya, June 9, 1866. Still more at Pultusk in 1868. Several thousand were also picked up after a fall at Estherville, Emmett County, Iowa, May 10, 1879. In such a rain of meteorites the fragments vary greatly in size, some weighing less than a grain, while the largest may weigh a hundred pounds or more. In most cases the peculiar characters or composition of the various specimens make it easy to recognize them as fragments of the same mass. In the case of the Estherville meteorite most of the pieces were coated with a fused crust, owing to the explosion having taken place before they had lost their great velocity.

In the case of a stone which fell at Butsura in 1861, fragments found three or four miles apart could be fitted together, and some of the pieces, though fitting perfectly, had been coated on the faces of juncture with a thin crust, showing that they had been blown apart when the meteorite was still very high in the air.

Meteorites, when not seen to fall, are easily recognized, not only by the characteristic fused crust and pittings already referred to, but by certain very marked peculiarities of structure. There are three large groups: those consisting of metallic iron; those consisting of earthy minerals containing only grains of metallic iron; and those like the Pallas, made up of a continuous network of iron inclosing stony matter. The stony meteorites are usually made up of little rounded grains imbedded in a ground-mass of fragments of the same material, a type of structure called chondritic, which in its details is so characteristic that pieces of the same mass can usually be easily identified, even though found at places or times remote from each other. The iron meteorites are still more easily recognized, although only about nine at most have been seen to fall; for, since iron has not been found in masses of any size in terrestrial rocks, unless in Greenland, these large meteoric fragments are at once noticed wherever found. Stony ones, on the contrary, are not only apt to be overlooked, but the falls of past ages must have been altered and broken up by weathering. Meteoric iron can be easily identified, because it is usually extremely malleable, but at the same time very tough, owing to its being made up of a network of crystalline plates, the plates consisting of pure iron, bounded by layers of an iron-nickel alloy and other impurities, which have separated

out during a slow process of crystallization, evidently from a melted condition. This structure is best seen on a polished surface which has been subject to tempering, or else etched with acid. The acid, acting most readily upon the purest parts of the iron, develops certain figures called Widmanstättian figures if the plates are broad and well marked, and called Neumann lines where they are reduced to fine markings. Till recently, these two varieties of etched figures were supposed to indicate a difference of crystalline structure; but, by a study of the Harvard collection (American Journal of Science, third series, vol. xxxii, p. 284), it has been shown to depend on the time of crystallization —that is to say, on merely the size of the crystals, and not a difference of form. In some cases these etched figures serve conclusively to distinguish irons of different falls, but frequently they vary on the same specimen, or depend on the direction in which the surface is cut; but there are large groups of irons closely resembling each other in their etched characters. The distinction of such irons has become of great importance, since the enormous prices paid for meteorites offers a strong inducement to multiply supposed falls. Iron meteorites are often cut up and distributed by the finders before they have been fully identified, and the confusion is further increased by the natural distribution due to the explosions in the upper atmosphere. Thus a meteorite which fell in Cocke County, Tennessee, some time previous to 1840, has been turning up at various places ever since, and the numerous fragments have been described from time to time under various names as different falls.

In an attempt to prove that an iron which was found in Maverick County, Kentucky, was identical with two Mexican ones, in the Harvard collection (Proceedings of the American Academy of Arts and Sciences, vol. xxiv, p. 30), the writer found that on breaking slabs of the respective irons the two Mexican specimens, which had been generally accepted as identical, showed a marked difference of structure. One of them, known as the Butcher iron, when broken in various directions by blows of a hammer, always exhibited most brilliant and complex crystal faces, some of them half an inch in diameter, certain of the faces being most beautifully marked by a system of fine parallel lines arranged at certain fixed angles. The second iron, on the other hand, from Santa Rosa, would only break in two definite directions, exhibiting a single face with little flaky surfaces, but none of the fine lines. This last iron, if sawed to a thin edge, and then forced to break in a different direction from the two just mentioned, showed only a series of little cube faces, very different from the Butcher iron.

On a similar examination of other irons resembling the two Mexican ones in the figures brought out by etching, irons from

Allen and Maverick Counties, Kentucky, and Chattooga County, Georgia, appeared to be identical with the one from Santa Rosa, though found at places so distant from each other and described as independent falls, while none showed the striking fracture of the Butcher specimens.

As the irons examined were among the most compact and malleable of any in our collections, the result suggests a new way of identifying fragments of the same original mass, where external features are not sufficiently decisive, and, moreover, shows the care that must be taken in determining supposed new falls.

OBSERVATIONS UPON DOUBLING OF FLOWERS.

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FUNCTIONALLY a flower is for the production of offspring, and in structure it may be considered as a transformed stem with its metamorphosed leaves. In a typical flower—that is, one having all the parts present and in an easily recognized form—there are four sets of organs. The calyx forms the outer whorl of leafy organs, and next within is the corolla, usually bright-colored and showy. Inside of these two cycles of floral envelopes are the essential organs: first the stamens, which bear the male element as pollen-grains; and the pistil or pistils, occupying the center of the flower, the lower portion of which bears the seeds. In the production of seed we find the aim and end of all floral structures. The pistil remains after the flowering period is past and becomes the fruit, which may or may not be accompanied by other portions of the flower. The stamens serve their purpose as they shed their pollen, and usually quickly wither away, and the latter is generally true of the petals.

As above stated, all the several parts of a flower are now considered as modified leaves. The calyx is often green, leafy, and indistinguishable from ordinary foliage. All gradations may be found between calyx and corolla. The bright color is no argument against petals being leaves, for leaves of the common sort often assume the most brilliant colorations. Other wild plants illustrate the transition from petals to stamens—as, for example, the flowers of the water-lilies; and pistils are frequently broad, green, and leaf-like, especially after the seeds are ripe, and the two infolded halves open out and take on the form and function of foliage.

We do not need to extend our examination upon this point in search of proof for the morphological significance of the floral

structures, but plants under cultivation sometimes throw off some of their disguises and give additional evidence of no mean importance. Just as the man under the influence of intoxicating liquor may reveal qualities of his nature that might have otherwise remained securely hidden, so the distortions seen in cultivated blossoms furnish a key which unlocks the secrets of normal structures.

The common garden lily (*Lilium tigrinum*) often has, instead of the six normal and similar parts to the perianth—the six stamens and a single tricarpellary ovary—first a multiplication of the petals and sepals, usually about twelve, followed (passing inward in the flower) by a number of petal-stamens or stamen-petals. The outer of these last have nearly lost their stamen characteristics, being broad, highly colored, spotted, and with only vestiges of anthers; while the inner ones are exceedingly irregular, and suggest that a severe struggle might have taken place between a hidden force that unimpeded would have made a petal, and another aiming to produce a stamen. In all such flowers there were no perfect stamens; however, some of the petal-stamens bore anther-lobes along their contorted edges, in which seemingly perfect pollen-grains were produced in quantity. The pistil in all these doubled flowers is an amalgamation of five or more carpels, but the tricarpellary type is not obliterated. In one instance a petaloid structure was observed, with ovules arranged along the mid-rib upon the upper side; while above the two widely separated edges were lines of chocolate color, characteristic of the anther-lobes. In another instance the perianth was reduced to a spathe-like structure, upon the inner veins of which were long double lines of ovules. Within this structure was a much misshapen pistil, compounded of at least six carpels, judging from the styles and sections made of the ovary.

In the ordinary case of doubling it is considered that a stamen is replaced by a petal, and the additional petals of the doubled flower are limited in number by that of the stamens. It is at once seen that this view does not hold with the lily; for, in place of the six normal stamens, there are at least twelve petals, only a few of the inner ones of which retain any marks of stamens. There is, therefore, an augmentation of the petals and transformation of the stamens. In the cultivated tulip the perianth is often increased to three or more times the normal number (six) of parts, and in one flower the modified stamens were found increased to nine. The pistil frequently shows signs of transforming into petals and becomes winged and bright-colored along one or more sutures, while the ovules are sometimes exposed to view between the separated valves.

The common garden pæonia is another large-flowered species,

but quite unlike the lily or tulip, because the stamens are very numerous in each blossom. In this plant there is no need of speculating as to the origin of the petals. They arise in large numbers from the failure of the stamens to develop as such. The filaments broaden out upon opposite sides and a petal results. In nearly half such petals the remnant of an anther can be seen at the tip of the petal, which is somewhat notched, often deeply, and in the center is the abortive anther. Near the center of the flower the transition is more evident, for here the filament-wings are not much broadened, and the anthers more prominent. Still nearer the great center pistil the ordinary stamens may be found, with their anthers bearing pollen. Occasionally the poppy illustrates a modification of the stamen in the opposite direction to that given above—namely, the inner ones become small simple pistils, which are either closely applied to the surface of the large central compound pistil, or adherent to it and blending with the stigmas.

The rose family and the crowfoots both furnish a long list of plants which uniformly produce double flowers under cultivation, and for this reason these two orders are rich in ornamental garden species. Both the roses and the buttercups abound in stamens; and, from what we have seen in the poppy, it should be expected that doubling would be easy in such plants. The examples of doubled flowers in these two families are so familiar that no further comment need be made. Among the hardy cultivated roses, for example, it is rarely that a blossom can be found not exhibiting all gradations between perfect stamens and unmistakable petals. It may, however, be stated that in a member of the rose family grown for its fruit—namely, the apple—petal-stamens were frequently met with. In the Tallman sweeting variety, upon one tree, the doubling was found as frequently as one flower in ten. Usually one stamen was transformed, but rarely so much so as to be distinctly petaline.

The abnormities which we have been considering, both generically and specifically, are rarely met with in wild plants in a state of nature. They are, therefore, transformations in flowers concomitant with culture. It is a well-established fact that culture induces changes in those parts for which the plant is cultivated and it might be added that they are cultivated because of this response. Varieties of any cereal differ mostly in the grain; beets, carrots, and turnips in the roots; apples, plums, and peaches in the fruit; and so on. In accordance with the general rule, plants grown for their flowers should vary most in the blossoms. A plant when under cultivation has been removed from the conditions which obtain in the wild state and is relieved from that fierce struggle for life which is everywhere in progress among

feral plants. In other words, the cultivated plant is living an unnatural existence; stimulated by man's careful attention and guided by his will, it yields to the demands of its guardian. Variations quickly arise under such fostering conditions, and such changes as are advantageous to man are, if possible, perpetuated by him. This perpetuity in many instances can only be accomplished by non-sexual methods, as by cuttings, graftings, etc., and it therefore follows that the seeding process is either ignored or prevailed against. With their energies all turned in some other channel, plants may in time cease to develop seed.

A flower of the showy sort we may consider as the product of two great forces or groups of forces—namely, that which is *within* the plant, and for the lack of a better term may be called the *constructive ability* of the plant; and those forces which act from *without*, and are included in the general term *environment*. The chief factor in this last or external force is the modifying influence of insects, due primarily to irritation. For example, the lily-flower in its wild state has reached its present condition because the mother plants and their insect attendants have worked together to produce a structure that is admirably adapted to the needs of each. It is, it seems to me, not asking too much of any one who is a disciple of evolution, even in its mildest form, to conceive that the simplest wind-fertilized flowers were the first of all floral structures to appear in the far-away geologic times. In those early ages, provided that we base our reasoning upon what is seen to-day, it is easy to understand that out of the foliar structures there were evolved the primitive ovary and the ante-Adamite stamen. That ancient ovary might stand in striking contrast with the simple pistil of a pine-cone or leaf serration of a cycas, and the corresponding stamen was perhaps only a slight modification of a common leaf. But out of these primitive essential organs came, by slow but by an ever-advancing adaptation to the surrounding world, the wonderful combinations of color, odor, and form which we see in the more complex floral structures of the present day.

All the conspicuous parts of the flower outside of the essential organs are for the purpose of securing a transfer of pollen from the stamen of one flower to the pistil of another. This process of cross-fertilization, as has been abundantly shown, is an advantage to the offspring, which are stronger and therefore better able to cope with surrounding rivals. Therefore, any change in floral structure, however slight, born of accident as some would say, or the result of an inward impulse to improve, is one step toward that ideal condition of perfect adaptation between a plant and its surroundings. So far as the sexual elements are concerned, this ideal adjustment seems to be that of wide separation, and accord-

ing to this view we find an explanation for the actual separation upon different plants of stamens and pistils in dicœcious species, in different flowers in moncœcious plants, and their practical separation in all cases when the stamens and pistils in perfect flowers mature at different times (dicogamy). Again, there is a long list of plants in which wide fertilization is secured by one flower having long stamens and short pistils, and another of the same species with short stamens and long pistils (dimorphism). Aside from all these well-defined plans for crossing, there are hundreds of others none the less obscure and often vastly more ingenious—plans so well worked out that the plant will fail to produce seeds unless a particular kind of insect visits it. All such species are constantly striving to arrive at a perfect adaptation between the flower and the peculiarities of its insect attendant. In short, the plan for wide fertilization is so thoroughly apparent along the many lines, that Darwin expressed the condition in the following concise and striking terms: "Nature abhors continual close fertilization."

The structure and form of the essential organs, like those of the floral envelopes, have come to their present condition through the prolonged interaction of plant and insect. Now, at the outset plants cultivated for their flowers were those already showy—that is, those in which the floral envelopes were conspicuous, fantastic, or sweet-scented. Let us bear in mind that these showy wild flowers became so in competition with hundreds of other species, and underwent all the expense of floral display for purely selfish ends. Each species worked out the problem of reproduction in its own way; and it is safe to assert that it became as much a part of the life of a wild rose to develop bright petals as to form compound leaves with large stipules.

In the historic development of such flowers it may be assumed that the essential organs came first, and the surrounding parts appeared and were preserved as they were found of service to the plant. As time went on, additional stamens and pistils may have been added, until the most economical number of parts was reached—if it has been reached. The number varies in many of the wild species to-day, and especially in those prominent in the flower-garden.

It is only fair to hold the successful floriculturist responsible for much of the seemingly stable increase of display in cultivated plants over their wild forms. This is the same credit that is freely given to the horticulturist who increases the size, for example, of the strawberry, by crossing, selection, etc., possibly at the expense of stamens, as seen in many of the pistillate sorts. By granting this there is no intention of overlooking the long-established tendency in the wild plant to develop

in the direction taken when placed under the favoring conditions of culture.

Garden plants illustrate with accelerated force the working of the universal law of compensation. Fruits not only enlarge, but become seedless. Therefore, the increase in the size and other modifications in the flowers of such plants as are grown for their blossoms is only in accordance with a general law. An augmentation of floral parts is only a step beyond the increase in size of parts already present, and may be largely a matter of convenience in the arrangement of the parts in the bud. When we remember that any augmentation in the petals, etc., would be seized upon by the gardener, and if possible reproduced, the wonder is that the increase is not greater than it is. It is not claimed that such an augmentation is a direct advantage to the plant, any more than is the exaggerated size of a cabbage-head or the thick, rich pulp of a grape, especially when the cabbage splits open and falls apart of its own weight, or the grape-pulp monopolizes the whole substance, and no seeds result. When the guiding hand of man is withdrawn, cultivated plants soon or late find their way back to a stable condition called the natural form, and are again able to cope with their neighbors, depending entirely upon the conditions attendant upon the wild state.

The point that now calls for our attention is the development of one floral organ out of another widely differing from it in appearance. Augmentation, we have seen, is to be expected, but metamorphosis usually brings surprise. The unnaturalness of this arises in part from the constancy of organs in wild plants, and the general impression that a manifest difference in structure and use must indicate dissimilar origin of the parts. All of the various organs of a flower are now, as before stated, generally considered as lateral outgrowths from the stem, and in a state of nature their number, size, shape, color, etc., depend upon the service of each in the economy of the plant. In origin and early growth, therefore, there is no microscopic difference between the sepals, petals, stamens, and pistils. As shown at the beginning of this paper, by taking the whole range of wild plants, it is not difficult to find all gradations, from the outermost sepal to the central pistil. If these various parts have a common origin—namely, in minute cellular outgrowths afterward connected with the primary axis by a vascular cord—the wonder is that each type is adhered to so closely in the wild forms, and the surprise should be that under the modifying conditions of culture more striking combinations are not found. The petals (that is, the inner whorl of floral envelopes) and the stamens (the outer circle of essential organs) form the boundaries between the two primary divisions of the complete flower. It is here that the line of separation is

most frequently broken, and especially in those flowers having an indefinite number of stamens and petals. In such plants in the wild state there is usually no established uniform number for either of these parts, and it may be that they vary as circumstances determine. In such cases it seems more natural to suppose that one gives place to the other, than that there is an independent development of a new part. However, when we come to the cultivated plants, this seeming chasm between petals and stamens is bridged, and the difficulty now turns upon deciding whether a certain organ is more or less stamen than petal.

As seen from both a physiological and morphological point of view, the pistil is considered the most highly differentiated part of the flower, the stamen next, petal next, and sepal least. Under the conditions obtaining with the cultivated rose, stamens are less important than petals, and probably less easily produced. Instead of the slender filament surmounted by the two lobes of the anther, bearing thousands of expensive pollen-grains, there is a broad, loose-celled, showy petal. When a stamen is replaced by a petal, it is naturally termed retrograde metamorphosis. In the rose, as in many other cultivated plants, all gradations may be found, from a normal stamen, with a slight color-line along one side of the slender filament, to the perfect petal, which may have a small notch at the tip, marking where the anther might have been. So long as the demand for self-propagation is met in other ways, the tendency to produce seed may be overcome, and the plant spends its energies in the formation of showy blossoms, possibly losing, for the time at least, the power to ripen seed. If the selective power of the rosarian is now withdrawn, while at the same time the stimulation of high culture remains, the inference is not unwarranted that the retrogression would continue so far that no flowers develop. It may be that the so-called green roses sometimes met with furnish solid ground for such a view. At any rate, they are forcible examples of the throwing off of floral disguises, and the true nature of the parts becomes evident to the most skeptical.

Rosaceous flowers furnish examples of the simplest form of doubling. In many others the struggle between the two forces seems to have been more violent, and the results are far from uniform, even in the same flower. In some species the broadening of the stamen takes place above the anther, as if the filament had become prolonged and petaloid. Frequently with such structures the rudimentary anther is at the base of the petal, or one half is midway upon one side, and the other opposite it, the connective having broadened out into the body of the petal. It is not unusual to find one half of the organ petaloid, while the other is contracted, contorted, and bears an anther-lobe containing fully

developed pollen. In the petunia the doubling of the flower is usually accompanied by a remarkable modification of the pistil —in short, a secondary flower is formed within the ovary. Botanists have long recognized an exceptional development of the floral axis which has been termed prolification. In this there may be a prolongation of the axis beyond the blossom, and the development upon it of ordinary foliage. The European larch furnishes a good illustration of this. Sometimes an ordinary leafy stem extends upward from the center of the cone for nearly a foot. In rare cases leafy branches have grown out from the free or blossom end of pears, and buds and long branches have arisen from the center of a rose. In the petunia this prolification, if we may call it such, assumes the form of a small and much-contorted flower. Repeated examinations of normal flowers fail to show any unusual structure to the pistil. It is, therefore, associated with the doubling process in the petunia. Instead of the end of the floral axis, which terminates at the base of the single centrally situated pistil, remaining as such, it develops into another flower, and this within the ovary of the primary blossom. Just why we should have this peculiar form of prolification, or any, in fact, is not for us to decide. The ordinary forces which would construct a normal flower have been thrown into confusion, and retrograde metamorphoses and floral prolification have resulted. In fact, it seems evident that out of the substance ordinarily producing a capsule of petunia-seed has been formed in the same ovary an amalgamation of stamens, petals, and a rudimentary pistil. In short, the tendency to petaline display does not stop with the stamens, but invades the pistil, and transforms it as already described.

After doubling has once become established, and the tendency is an hereditary trait, it still remains true that surrounding conditions may favor or modify it. It is well known that among wild plants the absence of favoring surroundings will hasten the period of reproduction, and even augment the yield of fruit. With doubled flowering plants it may be that they strive toward the same end, but fall short because of non-reproductive tendencies developed in them by long-continued culture for their showy flowers only.

A RELATIONSHIP between the flora of eastern Asia and of eastern North America was pointed out, as to Japan, by Dr. Asa Gray thirty years ago. It has been illustrated since by discoveries of new species alike in both regions, but they have been for the most part unimportant herbs. Greater force is now given to the fact by the discovery, by Dr. Augustine Henry, that the Chinese and American tulip-trees are identical. The discovery is significant in that it gives evidence that the climates of eastern America and of China have continued to be alike since the Tertiary period.

TELPHERAGE IN PRACTICAL USE.

By FREDERIK A. FERNALD.

A VAST field of application which electricity is only just entering upon is the transportation of freight and passengers. The use of electric motors for propelling passenger-cars on street railways may be said to have passed through the experimental stage into the domain of commerce. There are roads, using one or another of four or five different systems, in operation or in process of construction, in all parts of the United States, and new contracts are frequently being announced. Nothing, however, has been accomplished in this country in the direction of carrying freight by electricity. But a system, called "Telpherage," has been worked out in England, which is especially adapted to take the place of horses in carting, as they are already being displaced from the propelling of cars.

Telpherage may be regarded as a development of what is called in England the "wire-rope haulage" system, by which freight is conveyed in buckets suspended by a grip from an elevated wire cable. For distances of a few hundred feet, an inclined cable, down which loaded buckets suspended on traveling wheels move by their own weight, has also been used. The telpher system resulted from a union of the joint inventions of Profs. W. E. Ayrton and John Perry with those of Prof. Fleeming Jenkin. Prof. Jenkin had had in mind for some time the idea of propelling electrically a continuous stream of light trains without attendants along an elevated single rope or rail, which should be also the conductor of the electricity. He had not solved the problem of preventing automatically these trains from running into one another, when he read an account of the plan for dividing electrically the rubbed conductor of electric railways into sections, devised by Profs. Ayrton and Perry, and described by the former in a lecture at the Royal Institution, London, toward the close of 1882. This plan, designed to prevent leakage of electricity, also furnished an absolute block, cutting off the power automatically from any train whenever it approached too close to the one in front of it. At Prof. Jenkin's suggestion, a partnership was entered into by these three gentlemen, and "The Telpherage Company" was soon afterward formed, to bring their system into practical use. Experimental work was carried on for over two years on the estate of Mr. Melton R. Pryor, the chairman of the company.

Various details of construction were worked out in these experiments, and at the beginning of 1885 the scheme was sufficiently developed to be put in practical operation. Arrangements

were made with the Sussex Portland Cement Company for building a telpher line to carry clay from the clay-pits on Lord Hampden's estate at Glynde, in Sussex, to the Glynde Railway station. While this work was in progress, Prof. Jenkin died, and was succeeded as engineer of the Telpherage Company by Prof. Perry, under whose direction the line was completed. It was put in operation October 17, 1885. The general appearance of the Glynde telpher line is shown in Fig. 1, and the following description of it

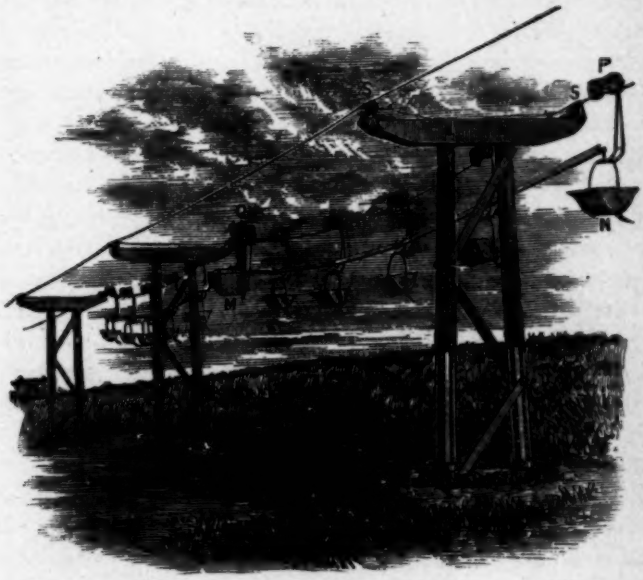

FIG. 1.—PART OF THE TELPHER LINE AT GLYNDE.

is based upon lectures delivered by Prof. Jenkin and Prof. Perry. The structure consists of a line of posts, eighteen feet high and sixty-six feet apart, with cross-heads eight feet long at the top. Instead of a cable, as used in the wire-rope haulage system, it was found better to have round steel rods, three quarters of an inch thick, running from post to post for the buckets, or "skeps," to travel on. The ends of the rods are fastened to cast-iron saddles. As the train of skeps runs on a single rail, a double track, or two lines of rods, can be supported at the two ends of the cross-heads on the single line of posts. As would be expected, these slender rods sag somewhat under the weight of the loaded skeps, but the trains are made of the length either of one span or two spans, so that the part of the train coming up out of the depression is helped on by the weight of the part just going down into it. The sagging makes the mechanical resistance but little more than is experienced in hauling a train of the same weight along a rigid track, while the use of flexible rods enables the road to be built

much more lightly and hence much more cheaply than if stiff rails were used. On curves, sidings, and sections for loading and unloading, however, it is found better to employ the stiff rails, which are supported by posts thirteen feet apart. The form of

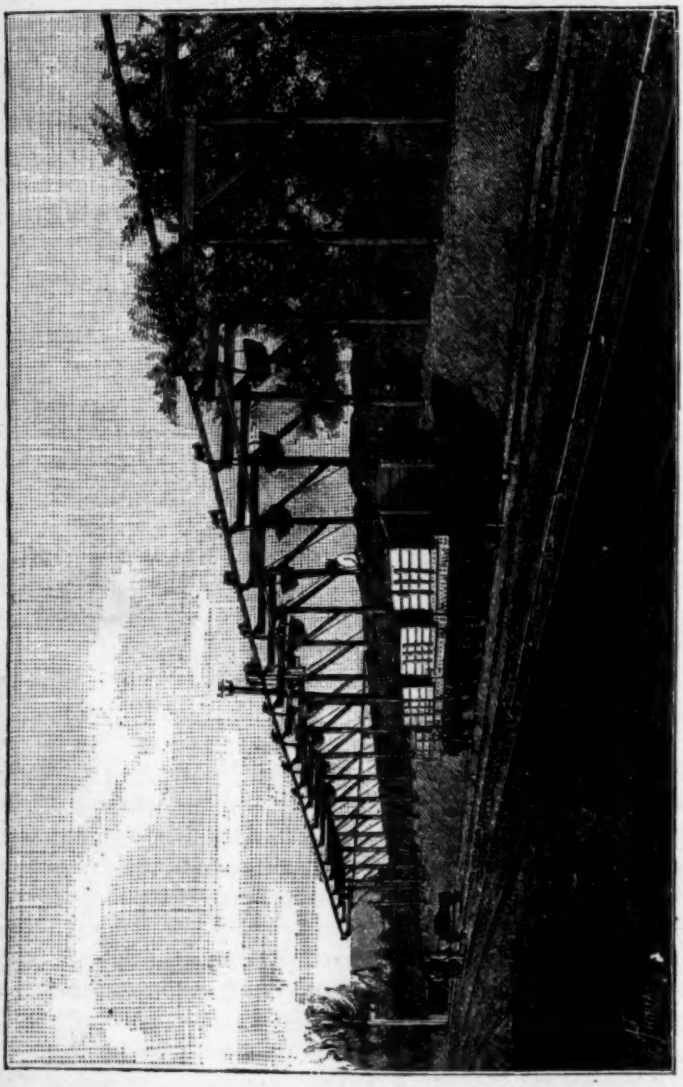

FIG. 2.—A TELPHER TRAIN AT THE RAILWAY SIDING.

switch which has been devised for telpher lines consists of a hinged stiff blade of steel, which allows a train to run off on to a stiff siding, when it is lowered so as to rest on the main line.

At intervals along the line straining-posts are placed, each of which acts as an abutment for a number of spans on one side, and carries a compensation gear, by which an equal number of spans

on the other side are kept up to the proper tension. The compensation gear consists of a chain attached to the end of a rod, which here is not bolted to the saddle, and running down to a lever and weight beneath the track. These gears keep the tension of the rods uniform in spite of varying loads and temperature; on the line at Glynde the tension is two and a quarter tons. While this line was being constructed, Prof. Perry discovered that the tension of a rod could be determined very simply, by setting it to vibrating, and counting the vibrations in a quarter of a minute.

A train on the Glynde line consists of an electric locomotive and either five or ten skeps, in the latter case the locomotive being in the middle of the train. The skeps, are spaced evenly and somewhat widely apart, being connected by poles fourteen feet long, in order to distribute the weight of the loaded train over a considerable length of the rail, which allows the track to be light and correspondingly cheap, and in order also to have the train of the proper length to make the necessary electrical connections as it passes from span to span. The poles are attached to the buckets by a hook-and-eye coupling, easily detached. Each skep weighs one hundred and one pounds, and holds about two hundred and fifty pounds of dry clay. The cross-piece connecting the two wheels is of wood, so that the bucket, being suspended from this by a hanger, is insulated from the line, and may be handled without any shock being felt. An empty train at Glynde will travel to the clay-field where the track slopes down so as to bring the skeps nearly to the level of the ground. A laborer touches a key and stops the train, the skeps are then filled, the key is touched again, and the train starts off.

At the railway siding the train does not stop. The buckets pass above the middle of the cars, into which the clay is dumped automatically by the handle at the bottom of each bucket striking an arm projecting from a post. Any kind of a load, such as bags of grain or logs, may be hung from the hangers by replacing the buckets by bands, or a seat holding two passengers may be substituted for the bucket, which would allow of twenty passengers being drawn by one locomotive. For passenger lines, however, Prof. Perry says that it would be found probably more convenient to use a stiff rail rather than the flexible rod. A *single-wheeled* skep, suggested by Mr. Horace Darwin, has been given practical form by Mr. Gordon Wigan. A train of these skeps moves with less friction and is more flexible, so that it goes round curves more readily than a train of the two-wheeled skeps. Mr. Wigan has also designed a one-wheeled locomotive.

An end view of the "tandem locomotive," which is the form used at Glynde, is shown in Fig. 3.

This consists of a Reckenzaun motor, with the necessary gear-

ing, driving-wheels, etc. The locomotive is suspended by two wheels, Q, which have rubber tires. The electrical current passing through the motor drives it at the rate of sixteen hundred to seventeen hundred revolutions a minute, and the power is transmitted by the cog-wheels A and B to a second horizontal shaft on which is a chain-wheel, F. A chain going round this wheel, and round two chain-wheels at C, C, causes the two driving-wheels of the locomotive to rotate.

FIG. 3.—TANDEM LOCOMOTIVE (end view).

Various forms of grip and friction-gearing locomotives have been devised by the staff of the Telpherage Company, but it was found that the simple locomotive represented in the figure could go quite readily up inclines as steep as one foot rise in thirteen; no grades so steep as this were needed at Glynde, hence the more elaborate machines were not put in use there. Prof. Perry is confident that the simple locomotive would be effective on grades as steep as one in ten, if the rail be kept quite dry. It was found that the weight of the locomotive, which is not much greater than that of one of the loaded skeps, with the aid of the rubber tires produces enough friction on the rail for the propulsion of the train. In the wet season of the year the rubber tires will last only a fortnight, but in dry weather their life is much longer. Still, even on the wettest days the locomotive performs its work quite well.

It was feared at first that trains near the engine-house would move much faster than those which were farther away. But this difficulty is prevented by an electrical governor attached to each locomotive. In Fig. 4, D is the second shaft, and W W are the two weights of a centrifugal governor, which are held ordinarily in position near the axis by means of the spring S. When the weights fly apart to the dotted positions W′ and W′, they draw the lever into the dotted position and break the metallic contacts at *c*, so that no electricity can be received by the motor. But no spark is made at *c*, because, after the contact is broken there, a connection of small resistance is continued for a short time at *a*, between two carbons, or a piece of carbon and a piece of iron, one of which is compelled by a spring to follow the other for some distance. If the contact be suddenly broken when the motor is making seventeen hundred revolutions a minute, the electric current will remain cut off until the speed of the motor has become reduced to about fifteen hundred. The position of the governor on the

locomotive may be seen in Fig. 3, under the motor. While ascending a steep grade the current will be on for almost the whole time; while descending such a grade it will be off altogether; on level stretches it may be on for, say, a quarter of the whole time of running. This plan avoids all waste in switches or interposed resistances, and the current cut off by each governor is too small to injure the dynamo.

But since a train when going down a steep incline is liable to get up too great a speed, even without its motor receiving any

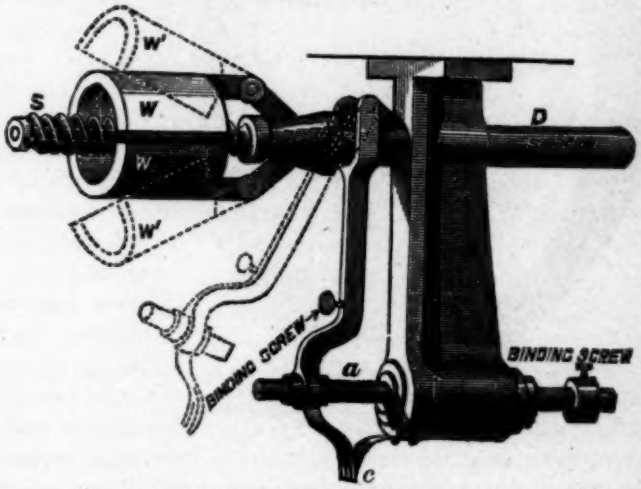

FIG. 4.—ELECTRICAL GOVERNOR.

electricity, the locomotive is provided also with a brake, shown in Fig. 5. This is placed on the shaft of the motor, and the edge of it may be seen in Fig. 3, beside the cog-wheel A. In Fig. 5, W W are two weights whose centrifugal force, up to a speed of eighteen hundred revolutions of the shaft A per minute, is balanced by the springs S S, but above that speed the weights draw outward and press the wooden brake-blocks B B against the metal ring C, which is fixed to the frame of the locomotive, thus retarding the motion of the train.

The method of working telpher trains employed at Glynde is what the inventors call the "Cross-over Parallel System." Fig. 6 is a diagram showing the electrical connections according to this system, where an up and a down track are used. Each track is divided into sections, each span of the ordinary length being a section. Alternate sections of each track, A_1, B_2, A_3, B_4, etc., are electrically connected together and to one pole of the generator of electricity D; the other sections are also connected together, and to the other pole of the generator. The two sets are well insulated from each other. Only two wheels of a train are employed

for making contact, and these wheels are just the length of a section apart. When the leading wheel L is on a negative section, as A_2, the trailing wheel T is on a positive section, A_1, and *vice versa*, so that a circuit is made between the poles of the generator through the rails, the two contact wheels of a train, and a wire connecting these wheels through the motor M on the locomotive, which thus receives its supply of electric energy. Of course, the current through the motor is stopped and reversed each time the contact wheels pass from a positive to a negative or a negative to a positive section, but this makes no difference with the direction in which the motor runs, nor does it injure the dynamo. We can cause the locomotive to run backward, however, by altering the positions of the commutator-brushes on the motor. In the case of a single track, the positive sections A_1, A_3, etc., would have to

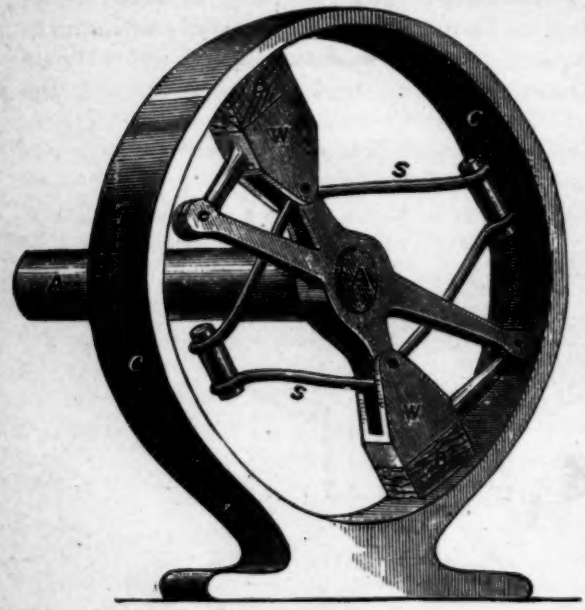

FIG. 5.—MECHANICAL BRAKE.

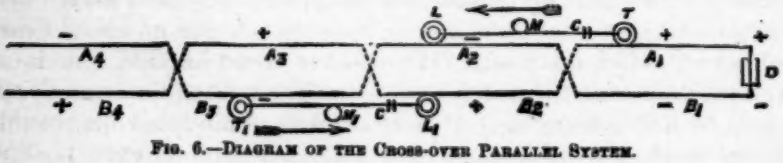

FIG. 6.—DIAGRAM OF THE CROSS-OVER PARALLEL SYSTEM.

be connected by a long wire instead of through the sections of rail B_3, B_4, etc. This system requires that the sections shall all be of equal length, which is sometimes inconvenient, as when broad gorges have to be crossed, and at curved parts of the line. But this difficulty can be overcome to some extent by employing a "gravitation section" longer than the distance between the contact wheels of a train. This section is constructed with a downward slope, so that the weight of the train will propel it over the part in which it receives no electric energy.

Fig. 7 shows how the ends of the steel rods are fastened and insulated from each other. The end of one rod is turned down and fastened to the cast-iron saddle with a nut, as shown at the right of the figure. The end of the next rod, A, is bolted to the cast-steel cap C, which is insulated from the saddle by an insulator of vulcanite, V; and, in order that the tension of the rods may not break the vulcanite, melted lead is run in between the

FIG. 7.—ORDINARY SADDLE.

saddle and the insulator, and between the insulator and the cap. To prevent the metallic wheels of the skeps from short-circuiting the two sections as they cross the tops of the posts, there are insulated gap-pieces, as shown in this figure, on the saddles between each rod and the next.

Each of the motors at Glynde receives a power of about fifteen hundred watts, or about two horse-power, and as the potential is about two hundred volts everywhere on the line, each motor receives about eight ampères when a train is running at about four and a half miles an hour. The dynamo used on this line is a Crompton six-unit "shunt-wound" machine of the Gramme type driven by a steam-engine. It is evident that a telpher line could be run with water-power, where this is available, even if the source of power is several miles from the track.

The line at Glynde is a little under a mile in length. On long lines it is expected that a source of power would be needed every ten miles, working the trains for five miles in each direction.

The advantages claimed for telpher lines over surface railroads using steam locomotives are, first, the much less cost of the road and equipment. Thus, as the result of the experience gained in constructing the Glynde line, it was estimated that a similar line could be erected for a total cost equal to about six thousand dollars, including engine, dynamo, track, and five trains, with

locomotives to carry one hundred tons a day. Where rivers and gorges have to be crossed and very uneven ground is to be passed over, no expensive bridging or grading has to be done. It is not necessary to buy the land over which the line runs; only a right of way need be acquired—for the tracks being elevated, the road does not interfere with the use of the ground for agricultural or other purposes. At Glynde this consideration was an important one, and the fact of the tracks being elevated was also important for the reason that sometimes in winter some of the fields over which the line passes are several feet deep in water. The presence of an electric line of conveyance may be an actual convenience for agricultural operations; for a root-cutter, a shearing-machine, a thrashing-machine, a circular saw, or any other agricultural machinery, may be driven by attaching a small electro-motor to the machine, and connecting it by wires with the rods of the line.

A train of ten loaded skeps, on a road of flexible rods such as has just been described, weighs about two tons, yet lines can be designed, especially when stiff rails are used, that will carry almost as heavy loads as desired. Yet telpher lines are especially applicable where the traffic is not large enough, or the difficulties of construction are too great, to make an ordinary railroad profitable, and where the goods would be conveyed in carts or on pack-horses. Prof. Perry estimates that on a railway the cost of transporting freight is about 1*d.* per ton per mile, if there is a sufficient amount of traffic; that on a telpher line the cost is from 2½*d.* per ton mile to 3½*d.*; whereas cartage can not be performed at much less than 1*s.* per ton mile, and even at this high price the cost of constructing the cart-road and keeping it in repair is left out of account. Telpherage is claimed to be superior to the wire-rope haulage system in its power to turn sharp corners with ease.

It was reported in the spring of last year that the Glynde line had given every satisfaction under continuous working for over three years, and that negotiations were in progress for the erection of telpher lines both in England and abroad. Among the contracts then recently made was one for two lines in Cornwall, for the carriage respectively of one thousand and five hundred tons of tin ore a week.

In regard to possible applications of telpherage Prof. Perry has said: "As we have it at present, it will not only be very useful in bringing ore from mines, but it is easy to arrange for a telpher line which will load or unload a vessel which is unable to come close to shore on account of the shallowness of the water, and we can imagine these trains of skeps running out over the sea, running down into the hold of a vessel, running up again, and

coming back to land. . . . We have at present very modest aims. I should prefer for some time to simply develop lines like the one at Glynde; but I am quite sure that in future, when more capital than we have had at our command is employed to develop the system, we shall have trains of skeps passing down empty into coal-mines and along the workings, to be filled by the men as they dig the coal from the face, coming back to the bottom of the pit, and, moving up a vertical rod, passing on to the ordinary lines at the surface, and then without stopping, except perhaps to be labeled, traveling along, shunted from point to point by men properly stationed, who will know what to do with each train by the ticket upon it, until they will eventually reach the door of the customer who is to use the coal. The immense amount of worry which there has been in the development of telpherage, even as we now see it, shows me that its grandest developments can not come in my own time; but that it must come in the long run; and that telpherage will be a general system of distribution of goods is a fact which is fixed in my mind so securely that no amount of disappointment or worry can remove it."

THE COMMERCIAL GEOGRAPHY OF SOUTH AMERICA.*

By GEORGE G. CHISHOLM, F. R. G. S.

THIS, the smaller half of the New World, has at least four fifths of its area within the tropics, and hence yields chiefly tropical products; but here as elsewhere the temperate area, relatively to its extent, furnishes a greater abundance of commercial commodities, and it is in this part of the continent that the rate of increase in the production of such commodities, and the development of means of distribution for them, are now most rapid, and European immigration is most constant.

The lofty chains of the Andes, on the west side of the continent, form an important climatic barrier. In the latitudes in which the trade winds prevail they arrest the moisture-laden winds from the Atlantic, draining the moisture out of winds that had already been partly drained in their course over the continent farther east. The Andes also constitute a great obstacle to communication between the east and west coasts. There is as yet no railway that completely crosses any part of them, though there are railways which reach a height of upward of fourteen thousand feet before attaining the table-lands between the principal chains of these mountains.

* From the author's Handbook of Commercial Geography, recently published by Longmans, Green & Co., London and New York.

Some of the mighty rivers to the east of the Andes form excellent water-ways. The Orinoco, in the north of the continent, is navigable for steamers continuously for nearly a thousand miles. The Amazon is navigable without interruption to the base of the Andes, a distance of twenty-six hundred miles from its mouth, and six thousand miles of navigation are afforded by the main stream and its tributaries. Many of these tributaries, however, have their navigable course greatly obstructed by falls and rapids. The value of the navigation of the Amazon is diminished by the paucity of population and products in the region through which it flows and by the similarity of the products in nearly the whole of its navigable course. The inland water-way, which is already of most importance, and likely to remain most useful to commerce in the future, is that from north to south formed by the upper Paraguay and the lower Parana, a water-way which is uninterrupted from near the source of the former river, and which, like the Mississippi, brings hot and temperate climates into direct communication. Its chief drawback is the extreme shallowness of its estuary, the Rio de la Plata, or River Plate.

The population is still very scanty, probably not more than thirty millions. Whites of pure blood form only from two to three tenths of the whole, negroes about one tenth, and the remainder either native Indians or people of mixed race; so that on the whole the Indian element still largely predominates. The white population in Brazil is of Portuguese origin, and Portuguese is there the official language; but elsewhere, except in Guiana, the whites are mainly of Spanish descent, and Spanish is the official language.

Brazil is an empire* which secured its independence of Portugal in 1822. In size it is the rival of the United States and Canada. Only a limited area has been turned to account for agriculture. Even the area which travelers in Brazil deem it possible to bring under cultivation at some future time is but a small fraction of the whole. The equatorial valley of the Amazon is filled with dense forests. Close to the coast, that trends in a southeasterly direction, stretch ranges of mountains which cut off the Atlantic moisture from the region behind. This region is made up mainly of low table-lands (*campos*) with a sterile soil. North of about 20° south—that is, throughout the broader part of the country south of the forests—these *campos* are considered fit for nothing but pasture. There remains nevertheless an area in the south—small, indeed, compared with the extent of the empire, but yet between four and five times the size of Great Britain—in which there are many fertile districts still unsettled, and a considerable

* [These pages were written before Brazil became a republic.—EDITOR.]

extent of these in latitudes fit for European settlers. Till recently the practice of slavery has deterred free immigrants from settling in those provinces in which the institution was most firmly established (those growing tropical products), but since 1871 it has been in process of abolition, and it was entirely abolished in 1888. Great efforts are hence being made by the Brazilian Government to attract immigrants to those districts in which a substitute for slave-labor is most needed. Immigrants, chiefly Italian and Portuguese, are now arriving in thousands. In the southernmost provinces, where slavery was never very general, German and Italian colonies have existed for many years. Railways are so far most numerous in the coffee region of Brazil. Of the projected railways, one of the most important is that designed to avoid the rapids of the Madeira, but for which steamers would be able to ascend to the base of the Bolivian table-land.

The capital of the empire is Rio Janeiro, which is also the chief seaport, and the principal outlet for the coffee region. Its harbor is admirable on account of its commodiousness and safety, and delightful on account of its beauty. The second port of this region is Santos, farther south. Bahia, or San Salvador, and Pernambuco are the seaports of the region producing sugar, cotton, and tobacco; Para, Maranham, and Ceara, those of the region yielding forest products—rubber, Brazil-nuts, cabinet and dye woods, together with cacao and sugar. The ports of the temperate region producing animal products are Rio Grande do Sul, Pelotas, and Porto Alegre, all of which are accessible only to vessels of small draught (under eleven feet), on account of a bar at the entrance to the shallow lake on which they all stand.

Colonial Guiana consists of three portions—one British, about equal to Great Britain in size; one Dutch (Surinam); and one French (Cayenne). Cultivation of plantation products (chiefly sugar-cane) is almost confined to the British and Dutch colonies, and in these to a strip of lowlands along the coast and the river-banks—a strip partly below sea-level, and protected by embankments. In British Guiana Demerara is the chief sugar district. The laborers are negroes, mulattoes, and coolies. In British Guiana a rich gold-field lies on the banks of the Cuyuni in the west, but it has long remained unworked on account of claims being made to this portion of the territory by the government of Venezuela. A rich gold-field is reported to have been recently discovered on the borders of Dutch and French territory. Cayenne is used by the French as a place of deportation for Arab convicts from Algeria.

Venezuela, a republic in the north of the continent, consists chiefly of the basin of the Orinoco. People of Spanish, Indian, and negro descent, all now free, make up the bulk of the popula-

tion; and the majority are settled on a small area of highland valleys in the northwest, where branches of the Andes strike northeastward, and then eastward parallel to the coast. The staple product is coffee; but cacao, cotton, tobacco, and sugar, besides other tropical products, are grown. Gold in the east and copper in the west are important minerals. The plains (*llanos*) of the Orinoco are devoted to cattle and horse rearing, an industry at one time much more flourishing than now. The chief inland towns are Carácas (the capital) and Valencia, which are situated in inland valleys from eighteen hundred to three thousand feet in height, and are connected by rail with their respective seaports, La Guayra and Porto (Puerto) Cabello. Ciudad Bolivar, on the Orinoco, the navigation of which is free to all nations, may also be ranked as a seaport, being accessible to sea-going vessels.

Colombia is a republic with a similar population to that of Venezuela, settled chiefly in the upper parts of the valleys of the Cauca and Magdalena, where, in consequence of the great elevation, the grains of temperate climates are grown. In the lowlands, on the other hand, rice is grown; and it is so generally eaten by the people that a deficiency of this commodity has to be made up for by import. The mineral wealth is great, and gold, silver, and precious stones take a leading place among the exports, which include also Peruvian bark and plantation products. The great channel of communication is the Magdalena, which is navigable for steamers without interruption as high as Honda, but on account of a bar at its mouth is connected with the sea by a short canal running westward to Cartagena, and a railway from Barranquilla to another seaport nearer the mouth of the river. The Panama Railway (from Colon or Aspinwall in the north to Panama in the south) and the Panama Canal belong to Colombian territory. Bogota, the capital, is within five degrees of the equator, but, in virtue of its situation at the height of eight thousand feet above sea-level, enjoys a healthy climate, with a temperature like that of a perpetual spring.

Ecuador is a republic chiefly south of the equator, but which owes its name to the fact that its capital, Quito, is almost under that line. Quito lies, like Bogota, between two chains of the Andes, its elevation being between nine and ten thousand feet. The only seaport is Guayaquil, whence cacao, grown on the western lowlands, is exported. At present communication is difficult between Guayaquil and the capital, but a railway between the two towns is now in progress. To Ecuador belong also the Galápagos, or Turtle Islands, a group situated on the equator, about seven hundred miles to the west.

Peru, a republic lying to the south of Ecuador, has a popula-

tion of about three millions, at least half of whom are pure Indians. It is composed of three zones: 1. A rainless coast strip, fertilized only here and there by rivers from the Andes, which afford the means of irrigation for sugar and cotton plantations tended by Chinese coolies. 2. The sierra, or valleys and table-lands of the Andes. On one of the table-lands lies (partly in Bolivia) Lake Titicaca, the largest lake in South America, at the height of twelve thousand five hundred feet above the sea. At this height even barley seldom ripens, and the only regular food-grain is derived from a native plant called *quinoa* (wholly unlike our cereals). 3. The Montaña, the region on the eastern slopes of the Andes, containing the head-waters of the Amazon, a region largely covered with impenetrable forests, of which the most valuable product is Peruvian bark. The capital of the country is Lima, an unhealthy city on the coast strip, a few miles from its port, Callao.

The chief exports are sugar, cotton, nitrate of soda, and llama, vicuña, and sheep's wool; the first three derived from the coast strip, the last from the sierra. Apart from nitrate of soda, the mineral wealth for which Peru (including Bolivia or Upper Peru) was long ago noted is at present commercially of little importance, but projects are now on foot for conferring renewed importance on them by the laying of railways. Among the railways already in existence in Peru are two of the most remarkable in the world, those namely by which the table-lands of the Andes are reached. One of these is the Lima-Oroya Railway (not yet completed), which attains in its passage through the western chain of the Andes a height of fifteen thousand six hundred feet. This railway it is proposed to continue northward to Cerro de Pasco, where there are immense deposits of silver-ore, though the silver-mines have been inundated for half a century. These it is proposed to reopen and work scientifically. The other Andes railway is from the southern seaport of Mollendo to Puno on Lake Titicaca, and this line it is now proposed to continue northward to Cuzco, the ancient capital of Peru. The value of this line has already been greatly increased by the establishment of steamboat traffic on Lake Titicaca and the river Desaguadero, the outlet connecting that lake with Lake Aullagas in Bolivia. Another railway project which has the prospect of being carried out is one for a line southward from Lima, to be afterward continued up the Andes to Huancavelica, where there are rich deposits of quicksilver. It is likewise proposed to bring the Montaña, now almost completely shut off from external commerce, into connection with the outside world by the laying of roads in the north to the Amazon. In this district cotton and coffee plantations have already been started with success.

Bolivia is a republic, now entirely inland, occupying the broadest part of the table-land of the Andes, with a montaña to the east. Its population is about two millions, inclusive of about eight hundred thousand uncivilized Indians. Even the civilized population is mainly of Indian origin. The communications of Bolivia with Peru and Brazil have already been referred to. The capital of the country is Sucre, on the part of the table-land drained to the east. La Paz is the chief town on the table-land of Lake Titicaca. The silver-mines of Potosi, which made Peru so valuable a possession to the Spaniards, belong to this state, and are still productive, though in a greatly diminished degree.

Chili, a republic, possesses the whole of the coast strip south of Peru, together with the islands that fringe the coast, including part of Tierra del Fuego and both sides of the Strait of Magellan except in the extreme east. The northern portion of the country is a continuation of the desert strip on the coast of Peru, and is valuable solely for its mineral products—guano (near the coast from the frontier to about 21½° south), nitrate of soda, or cubic niter, as it is also called (in the same latitudes, but farther inland), gold, silver, and copper. Copper is even more abundant farther south, along the base of the Andes, north and south of Coquimbo. Silver is also found more abundantly to the south of Copiapo. The middle portion of the territory (between about 33° and 38° south) contains the bulk of the population, who number about two million five hundred thousand in all. The agricultural products are mainly wheat, barley, and southern fruits—similar, in fact, to those of Spain, which has a climate resembling that of the more populous parts of Chili. Notwithstanding that whites predominate in this republic (instead of Indians and half-breeds as in most of the others), agriculture here also is generally in a backward condition, except in some parts of the north, where there are some admirable irrigation works. In the more thickly peopled part of the country there are several hundred miles of railway.

The capital of the country is Santiago, and its port is Valparaiso, on a fine bay looking to the north. Here is received the great bulk of the imports, but since the greater part of the exports consists of mineral produce, chiefly nitrate of soda, copper, and guano, the northern port of Iquique, whence most of the nitrate and guano is shipped, has the largest share in the export trade, Valparaiso coming only second, and Pisagua (another northern port) and Coquimbo next in order. Next to minerals wheat and other agricultural produce form the chief exports. The leading imports are manufactured articles, coal, and iron. The United Kingdom receives the bulk of the exports, and takes the first place in the import trade, Germany and France following,

and contributing together a share about equal to that of Great Britain. There is a considerable import trade in cattle and other animals from the Argentine Republic across the passes of the Andes, but the export trade by these routes is very scanty. The passes chiefly used are those near the latitude of Santiago, the Portillo and the Uspallata passes—the former nearly fourteen thousand feet in height, the latter about five hundred feet less. The Strait of Magellan is stormy and washed by strong tides, and hence difficult of navigation, so that sailing vessels still prefer the equally stormy, but for them less dangerous, route round Cape Horn, in the south of Tierra del Fuego.

The Argentine Republic comprises a territory of more than a million square miles, with a population of about four millions. This territory consists mainly of a vast plain sloping down to the Atlantic from the Andes, and other lofty mountains in the west and northwest. It extends from within the tropics to the south of the continent, embracing the eastern half of Tierra del Fuego, and thus includes a great variety of climate. The districts in which the population is most considerable and most rapidly increasing are chiefly those in the neighborhood of the estuary of La Plata and along the right bank of the lower Parana, where there are not only the greatest facilities for commerce, but where also the climate is most favorable to production and best suited to people of European stock. The provinces to which this description applies are Buenos Ayres, south of the estuary; Santa Fé, on the right bank of the lower Parana; Cordoba, to the west of Santa Fé; and Entre Rios, "between the rivers" Parana and Uruguay. The climate here is that of the warmer temperate latitudes, generally with an ample rainfall. Toward the interior the rainfall generally diminishes, and irrigation becomes necessary for cultivation. It is more abundant, however, in the neighborhood of the northern mountains, at the base of which there are sugar and other tropical or sub-tropical plantations. The plain extending eastward from these mountains to the river Paraguay is mainly a region of open forest, and is inhabited at present almost solely by a few tribes of wandering Indians. It is known as El Gran Chaco, or "great hunting-ground."

Of late years the Argentine Republic, together with the neighboring state of Uruguay, has been undergoing a rapid development similar to that of the United States and Canada. They are receiving streams of agricultural settlers, but in this southern region the settlers are mainly from southern Europe (Italy, Spain, and southern France). The Spanish and French immigrants include a large proportion of Basques, who are found to be among the most valuable colonists in these regions. In the thirty years ending 1886 upward of a million immigrants entered the country,

and in each of the three years 1886 to 1888 the number considerably exceeded one hundred thousand. The branch of agriculture mostly pursued by these immigrants is not tillage, as in the northern region of European immigration, but the rearing of live stock (chiefly sheep and cattle). Tillage, however, is receiving greater attention, especially in the agricultural colonies, which have been planted in large numbers since 1856, principally along the banks of the Parana; and the result of this is seen in the rising export of wheat and maize. The cultivation of maize is not at present nearly so extensive as the climate of the settled districts admits of, which is chiefly due to the want of a market for the produce; but there is reason to believe that its cultivation might be profitably stimulated by the establishment of the "pork-packing" industry on the same basis as in the United States.

The chief export is wool. The natural facilities for inland commerce afforded by the Paraguay and lower Parana have been mentioned; and here it may be added sea-going vessels can ascend the Parana to Rosario, that the Parana is likewise navigable for steamers above the confluence of the Paraguay as far as the limit of the Argentine frontier, that steamers can ascend the Uruguay River on the eastern frontier as far as the falls which occur in about 31½° south (at the Urugayan town of Salto), and that sea-going vessels of fourteen or fifteen feet draught can reach as high as the Uruguayan town of Paysandu. The Pilcomayo, on the northern frontier, is navigable for two hundred and forty miles, and the Rio Negro in the north of Patagonia affords three hundred miles of navigation through a region deemed a few years ago scarcely fit for settlement, but which is now being rapidly stocked and settled along the whole course of the river. Patagonia, the territory south of the Rio Negro, is mainly a stony desert, but recent explorations have shown that it embraces a considerable amount of fertile land along the base of the Andes. On the coast of this territory there has long been a Welsh colony at Chubut, in latitude 43°, where, among other things, wheat is grown.

As in the United States, railways are being rapidly extended to promote the commerce on which the immigration depends. The Argentine Republic is the part of South America in which railway construction has been, and still is, most active. There are projects for no less than three railways across the Andes into Chili. Of these the farthest advanced is the continuation of the railway from Buenos Ayres to Mendoza across the Uspallata Pass.

The capital of the republic is Buenos Ayres, which stands on the River Plate, and is at the same time the chief seaport, carrying on about one third of the shipping of the republic. This proportion would probably be larger if it were not for the defective-

ness of the port, which is one of the chief hindrances to the development of Argentine commerce. At present, in consequence of the rapid silting up of the River Plate, large vessels have to anchor ten miles from the city, and have not only to load and unload with the aid of lighters, but in certain states of the river large-wheeled carts have to be employed to convey goods and passengers from the lighters to the wharves. Great harbor-works are now, however, in progress with the view of providing a navigable channel to large docks that are to be constructed close beside the town. Lower down the estuary a new capital for the province of Buenos Ayres has been founded under the name of La Plata, and a port with docks and a navigable channel nowhere less than twenty-one feet in depth has here been provided.

Uruguay, a republic lying between the estuary of the La Plata and Brazil, has a similar surface, climate, and population, and similar industries to the neighboring provinces of the Argentine Republic, and is now being as rapidly developed. Among the railways there is one avoiding the rapids of the Uruguay River above Salto, and there is one in progress connecting Salto with the capital. Having a greater rainfall on the whole than the more populous districts of the Argentine Republic, Uruguay rears relatively to area more cattle than the latter country; and of the one million two hundred thousand animals that were annually slaughtered in the two republics for the making of preparations of meat, on the average of the ten years 1876–1885, about fifty-five per cent were slaughtered in Uruguay. This industry has made the small towns of Fray Bentos and Paysandu, on the Uruguay, well known throughout Europe. Among the countries sharing in the commerce of Uruguay, the United Kingdom has the first place both in imports and exports, supplying on the average of the years 1878–1885 nearly twenty-nine per cent in value of the imports, and receiving about twenty per cent of the exports. The capital of Uruguay is Montevideo, which has an excellent harbor.

Paraguay is an inland republic, lying mainly between the Paraguay and Parana Rivers, with a very sparse population, chiefly of native Indians. Its chief export product is the so-called Paraguay tea, or *maté*. Tobacco, timber, and skins are also exported.

The Falkland Islands, situated to the east of the Strait of Magellan, belong to the British. They have a damp, foggy climate, and are largely covered with peat, but are inhabited by a small number of settlers engaged in the rearing of sheep and cattle. They are frequently visited for repairs and supplies by vessels that have made the passage round Cape Horn.

SKETCH OF MATTHEW FONTAINE MAURY.

MRS. CORBIN, Lieutenant Maury's daughter and biographer, invokes for her father the reverence of the whole civilized world; for, she says in her Life, "the best part of his life was devoted to the performance of services which conferred benefits on the seafaring class of all countries, while the ideas to which he first gave birth have since borne fruit, and are likely to be useful to the whole human race." She adds that "in Maury we have two characteristics, each valuable in itself, but which almost invariably produce great results when they are combined. He was endowed with extraordinary powers of application and unflagging industry in working out the driest details. But he also possessed a vivid imagination, so that the dry bones of his new science were endowed with life and interest by the magic touch of his descriptive pen. It was Maury who created the science of the physical geography of the sea, and gave that impetus to its study which, in other hands, continues to produce results alike of practical and speculative importance."

MATTHEW FONTAINE MAURY was born in Spottsylvania County, Virginia, January 24, 1806, and died in Lexington, Va., February 1, 1873. He was descended on his father's side from two families of Huguenot exiles, already connected by marriage before they left France, who settled in Virginia in 1714. His father was the sixth son of the Rev. James Maury, an Episcopal clergyman and teacher of Albemarle County, Virginia, who numbered among his pupils three boys who afterward became Presidents of the United States, and five signers of the Declaration of Independence. This scholar appears to have been already interested in the great Northwest, and his speculations respecting the Missouri River, the Western mountains, and the rivers beyond them, then hardly known, greatly impressed his pupil Jefferson, who, when he became President, secured the dispatch of the expedition of Lewis and Clark.

When young Matthew was in his fifth year the family removed to Tennessee, near Franklin, where they lived the life of early settlers in a new country. His first ambition to become a mathematician was excited by an old cobbler "who used to send the shoes home to his customers with the soles all scratched over with little x's and y's." A fall from a tree in his twelfth year, by which his back was injured, for a time at least seriously, seems to have marked the turning-point of his life. His father, thinking him permanently disabled, yielding to his wish, sent him to Harpeth Academy, of which the Rev. J. H. Otey, afterward Protestant

Episcopal Bishop of Tennessee, and William C. Hasbrouck, were the teachers.

In 1825 he obtained, through the Hon. Sam Houston, a midshipman's warrant in the United States Navy. His father, not approving the career to which this pointed, while not forbidding, refused to countenance him in accepting it. Having thirty dollars which he had earned by doing tutor's work in the academy, young Maury went on his own account for the East. There was no naval academy then, and he went on shipboard at once. He soon showed that his mind was set upon mastering the theory and practice of his profession. "It is related by some of his companions of that period," says Mrs. Corbin, "how he would chalk diagrams in spherical trigonometry on the round-shot in the quarter-deck racks, to enable himself to master problems, while pacing to and fro, passing and repassing the shot-racks on his watch." With an old Spanish work on navigation, he pursued the double object of studying the Spanish language and adding to his stock of nautical information. His first voyage was to England, in the Brandywine, which conveyed General Lafayette home to France; his next was in the Vincennes, round the world. On this voyage he constructed a set of lunar tables and prepared himself for examination.

During his next cruise of four years on the Falmouth, Dolphin, and Potomac, beginning in 1831, Maury conceived the idea of his current and wind charts; observed and began to study the curious phenomenon of the low barometer off Cape Horn, concerning which he wrote his first scientific paper—for the American Journal of Science; and began to prepare for the press a work on navigation, for which he had been several years collecting the material. It was published in 1839, was favorably noticed in England, and was used as a text-book in the United States Navy.

Maury next received an appointment as astronomer and hydrographer on the South Sea Exploring Expedition, which was to go out under Commodore Catesby Jones, and, preparatory to it, practiced in the use of the telescope, transit instrument, and theodolite; but, Captain Wilkes succeeding to the command, he resigned, in order to permit the new commander to select his own associates. He was then assigned the duty of making surveys of Southern harbors. While traveling on leave of absence from this work, his leg was broken by the overturning of a stage-coach, whereby he was disabled from active service for several years. The misfortune is regarded by his biographer as having been a "blessing in disguise"; for it caused his mind to turn more intently to the scientific side of his work, and thus contributed indirectly to the fruitfulness of thought by which his after-life was distinguished.

A series of articles on naval reform and kindred subjects, entitled Scraps from the Lucky-Bag, published by Maury under

the pen-name of Harry Bluff, attracted attention and approval. Among the points discussed in them—most of which were brought up for the first time—were the adoption of steam as a motive power; great-circle sailing; the establishment of navy-yards and forts at Memphis and Pensacola; the use of blank charts on board public cruisers; the Gulf Stream and its causes; the connection of terrestrial magnetism with the circulation of the atmosphere; and a ship-canal from the Illinois River to Lake Michigan. The papers gave their author fame, and secured respect for his opinions on naval questions. He was placed in charge of the Depot of Charts and Instruments at Washington, an office which was developed into the Naval Observatory and Hydrographical Department. "No man," said Senator John Bell, "could have been found in the country better fitted than Maury for this difficult duty; and he worked with the zeal and energy that were expected of him."

One of Maury's first enterprises in this office was the compilation of his wind and current charts and sailing directions. He had already, as sailing-master of the Falmouth, in 1831, observed the want of trustworthy information concerning the winds and currents encountered by mariners. He then resolved, if he ever had opportunity, to compile such information from the store of old log-books in the Hydrographical Bureau of the Naval Department. This he now did, and his charts and sailing directions were furnished to the masters of vessels bound for foreign ports, who in turn supplied the results of their own observations. The most favorable reports came in of the value of the work, and it was illustrated by some then really wonderful incidents.

The fact was demonstrated in American and English journals that, by the mere shortening of voyages they made possible, these charts effected a very great saving in the expense of commerce between distant ports. Testimony was repeatedly borne to their value in the annual reports of the Navy Department and of congressional committees. Secretary Dobbin reported, in 1855, that other maritime nations, appreciating the value of this plan of investigation, had united in a common system of observations for its further prosecution; and that it was suggested by Lieutenant Maury that the same system of meteorological research, "if extended to the land, would afford for the agricultural interests of the country, and for science too, results quite as important as those which commerce and navigation have already received from it." While analyzing and tabulating these "millions of observations," Maury wrote his Physical Geography of the Sea, which took rank at once as a masterly as well as a charming work. In the preface to it the author attributed such success as he had achieved to the observance of the rule "to keep the mind unbiased by theories and speculations; never to have any wish that

an investigation should result in favor of this view in preference to that; and never to attempt by premature speculation to anticipate the results of investigations, but always to trust to the investigations themselves." The book met a large demand at home and abroad, more than twenty editions having been sold in England alone; and it was translated into the French, Dutch, Italian, Swedish, and Spanish languages. Following this came the assembling of the Meteorological Congress at Brussels, in 1853, of the chief nations interested in commerce, at which a uniform system of observations on land and at sea was resolved upon. Among the incidents of the conference was a letter in 1857 from Humboldt, "at the age of ninety years," relating to its results, and offering "to my illustrious friend and associate . . . the tribute of my respectful admiration. . . . It belongs to me, more than to any traveler of the age, to congratulate my illustrious friend upon the course which he has so gloriously opened."

Lieutenant Maury, after returning from the Brussels Conference, pressed the scheme of co-operation in meteorological observations on land. In addresses delivered at agricultural societies in 1855 he urged farmers to make daily observations of weather conditions and the state and yield of the crops, to be sent to him, as sailors were sending their observations at sea; and he advised them to seek from Congress measures for the establishment of a central office where these reports could be digested and the results sent monthly, weekly, or even daily, to all parts of the country, so that farmers could be "warned of the approach of storms, severe frosts, etc., that might prove injurious to the crops." He defined this proposition in an address before the United States Agricultural Society in January, 1856, as a concerted plan, the idea of which was to spread the network of instruments and observers in this country and over other parts of the world also, to which he was assured the co-operation of men of science abroad would be given. About three years afterward, in an address at Decatur, Ala., as if foreseeing that his services might become forgotten, he said: "Take notice, now, that this plan of crop and weather reports is my thunder; and if you see some one in Washington running away with it, then recollect, if you please, where the lightning came from." The whole record of Maury's meteorological work, and his part in advocating this plan, were reviewed by Senator Harlan, in a committee report to the United States Senate, made in 1857. His scheme also embraced a system of meteorological observations on the Great Lakes. Records had already been kept for many years by the army, to which, Maury acknowledged, "alone we are indebted for almost all we know concerning the climatology of the country"; but he explained that their value was retrospective; while the observations he proposed were to

be used for predictions and warnings of what the weather was to be.

As early as 1848 Maury had concluded, from his investigations of the winds and currents, that a broad and level plateau—the "telegraphic plateau"—existed at the bottom of the ocean between Newfoundland and Ireland. His view was confirmed by the deep-sea soundings that were taken at his instance between 1849 and 1853; and early in 1854 he reported to the Secretary of the Navy that, so far as the bottom of the deep sea was concerned, a submarine telegraph between Newfoundland and Ireland was practicable. A plateau seemed to have been placed there especially for holding the wires and keeping them out of harm's way. His views respecting the manner of constructing cables were confirmed, both in the behavior of the first cable, constructed differently from them, which failed, and the others, made more in harmony with them, which were successful. At the dinner given in celebration of the arrival of the first message across the Atlantic, Mr. Cyrus W. Field said, referring to the enterprise, "Maury furnished the brains, England gave the money, and I did the work."

A painful surprise came to Lieutenant Maury when the Naval Retiring Board, under the act of Congress of February 28, 1855, placed him on the retired list on leave-of-absence pay, but without detaching him from the Naval Observatory. He regarded the act as an indignity. He wrote to three of the Secretaries of the Navy under whom he had served for expressions concerning his efficiency, particularly inquiring why he had been kept at the observatory instead of being sent to sea. Ex-Secretary Graham answered: "I considered your services at the National Observatory of far more importance and value to the country and the navy than any that could be rendered by an officer of your grade at sea in the time of peace. Indeed, I doubt whether the triumphs of navigation and of the knowledge of the sea achieved under your superintendence of the observatory will not contribute as much to an effective naval service and to the national fame as the brilliant trophies of our arms." Mr. John P. Kennedy wrote, "From my knowledge of the nature of your scientific pursuits, their usefulness to the country, and your devotion to them, I can say that nothing but such an emergency as left me no alternative, would have induced me to withdraw you from your labors at the observatory by an order to go to sea." Mr. William Ballard Preston wrote to similar effect. In the following winter Maury was, by special act of Congress, reinstated and promoted to the rank of commander, with back pay from the date of his retirement.

Other schemes discussed by Lieutenant Maury in general or special papers, included the location of lighthouses on the Florida

and Gulf coasts; systematic observations of the rise and fall of the water in the Mississippi River and its tributaries, with gauges at all the principal towns; the redemption of the "drowned lands" of the Mississippi; navigation by great-circle routes; a ship-canal and railroad across the Isthmus, which he insisted should be by way of Panama or Nicaragua rather than Tehuantepec; the establishment of a great port at Norfolk, Va.; and the colonization of the surplus black and other population of the South in the valley of the Amazon. The Darien expedition of Lieutenant Strain and Lieutenant Herndon's exploration of the Amazon were connected with two of these schemes. The "lane route," followed by some of the transatlantic steamship lines, originated in the publication by Maury, in 1855, of a chart on which two lanes were laid down, each twenty-five miles broad, by following which the danger of collisions might be reduced. In acknowledgment of the value of the service rendered by this plan, and by the wind and current charts and sailing directions, the merchants and underwriters of New York presented him with five thousand dollars in gold and a handsome service of silver.

When the Ordinance of Secession was passed by the Legislature of Virginia, Commander Maury believed that his paramount obligation was to his native State. He accordingly left the service of the United States and identified his fortunes with those of Virginia and the Confederacy. There can be no doubt of his disinterestedness in taking this course. His merits and the value of his services were generally recognized throughout the North, and he had but recently given courses of lectures in the principal towns and cities, which were a series of popular ovations to him. In going into the service of the Confederacy he put himself under the direction, as his immediate superiors, of two men who, as United States Senators, had been prominent in opposition to his reinstatement after he had been put upon the retired list, and who are said to have been hostile to him before the war and through it. Of the manner of his leaving the service of the United States, he said, May 12, 1861, in a letter to a friend in Newburg, N. Y.: "I only saw last night the remarks of the Boston Traveller about Lieutenant Maury's treachery, his desertion, removal of buoys. It's all a lie! I resigned and left the observatory on Saturday the 12th ult. I worked as hard and as faithfully for 'Uncle Sam' up to three o'clock of that day as I ever did, and at three o'clock I turned everything—all the public property and records of the office—regularly over to Lieutenant Whiting, the proper officer in charge. I left in press Nautical Monograph, No. 3, one of the most valuable contributions I ever made to navigation; and, just as I left it, it is now in course of publication there, though I shall

probably not have the privilege of reading the proof. . . . As for the buoys, I touched them not!" The Grand Duke Constantine and Napoleon III offered him positions in Russia and France, respectively, which he declined. He became a member of a Council of Three to assist the Governor of Virginia, and in June, 1861, was appointed Chief of the Sea-coast, Harbor, and River Defenses of the South. He assisted in fitting out the Merrimac; invented a torpedo to be used for harbor and land defense; and was engaged, in the summer of 1862, in mining the James River below all the defenses, when he was ordered to go to Europe to purchase torpedo material. During the first and second years of the war he published a series of papers urging the building of a navy, and of protecting the bays and rivers with small floating batteries. He stayed in England, on Confederate business, till the surrender of Lee, when he dispatched a letter to the United States officer commanding the squadron of the Gulf, declaring that he regarded himself in the relation to the United States substantially of a prisoner of war. He then offered his services to Maximilian in Mexico, and accepted the position of Director of the Imperial Observatory. A plan he had conceived for the formation of a colony of Virginians in Mexico was accepted by Maximilian, and he was appointed Imperial Commissioner for Colonization. The scheme was, however, abandoned as soon as Maury left Mexico to return to England. His course in this matter was not approved by his friends, either in Europe or in America. It is claimed that he performed one great service for Mexico during his short career there, in introducing the cultivation of the cinchona-tree.

Returning to England in March, 1866, Maury was given a testimonial, by naval and scientific men, in recognition of his scientific worth and service. He was employed in Paris, by Napoleon III, to instruct a board of French officers in his system of defensive sea-mining. Returning to London, he opened a school of instruction in electric torpedoes, which was attended—at the expense of their governments—by officers of the Swedish, Dutch, and other nations. At the instance of Mr. C. B. Richardson, a New York publisher, he undertook a series of geographical text-books, saying as he went to his task, "I could not wind up my career more usefully (and usefulness is both honor and glory) than by helping to shape the character and mold the destinies of the rising generation." He also wrote a popular book on astronomy, which has never been published.

In 1868 Maury received the degree of LL. D. from the University of Cambridge, along with Alfred Tennyson, Max Müller, and Mr. Wright, the Egyptologist, and declined an invitation from Napoleon III to the directorship of the Imperial Observatory of France. Taking advantage of the general amnesty act to

return to the United States, he declined the offer of the superintendency of the University of the South at Suwanee, Tenn., to accept the professorship of Meteorology at the Virginia Military Institute. Pending his entrance upon the duties of this position, he considered a scheme for establishing a line of steamers between Norfolk and Flushing in Holland. During the last four years of his life he worked at a meteorological survey of Virginia. He engaged actively again in the advocacy of his old scheme for a Telegraphic Meteorological Bureau, in furtherance of which he repeated an address in Boston and Missouri and several places in the South. A paper on this subject presented to the International Congress, at St. Petersburg, for the Advancement of Geographic Knowledge, etc., was unanimously approved by that body. The exposure incident to travel in fulfilling his lecturing appointments brought on the illness which ended with his death; but he continued, to within a few days of that event, dictating and revising the last edition of his Physical Geography.

Commander Maury is described by his daughter as having been a stout man, about five feet six inches in height, with fresh, ruddy complexion, curling brown hair, and with every feature of his bright countenance bespeaking intellect, kindliness, and force of character. "His fine blue eyes beamed from under his broad forehead with thought and emotion, while his flexible mouth smiled with the pleasure of imparting to others the ideas which were ever welling up in his active brain. . . . His conversation was enjoyed by all who ever met him; he listened and learned while he conversed, and adapted himself to every capacity. He especially delighted in the company of young people, to whom his playful humor and gentle consideration made him very winning." N. P. Willis, speaking of him to a friend, said that he made him subject to his personal magnetism, and during a trip while they were together, "unconsciously furnished an exquisitely interesting study of character." He was a firm believer in the Christian religion, but did not join the church till 1867, when he was confirmed with his children in the Episcopal Church. His published works, books, pamphlets, and official papers were numerous, and bore reference to the researches which have been described in this sketch, concerning which they stand as original authorities. Orders were conferred upon him by the sovereigns of Russia, Denmark, Portugal, Belgium, and France; gold medals by those of Prussia, Austria, Sweden, Holland, Sardinia, France, and the free city of Bremen; and other honors by the Pope and Maximilian. He was a member of ten foreign and four American scientific and historical societies that are named, and of many other learned bodies of which the records were lost during the war.

CORRESPONDENCE.

VITIATED MORAL TEACHING.

Editor Popular Science Monthly:

SIR: The letter of E. P. Meredith, in the April Monthly, reviewing the article by Benjamin Reece on "Public Schools as affecting Crime and Vice" in your January number, does not seem to go to the root of the evils deprecated. It is true that high mental culture is not always accompanied by a correspondingly high ethical standard, but often the reverse, and that, as a general rule, our public-school teachers "bear an exceptionally good moral character, and a majority of them are members of good standing in the various churches," and that "the Sunday school, where moral training is especially attended to, is now considered an indispensable adjunct of every church; yet, with all this, vice and crime are on the ascending scale, and in a most astonishing degree." But when he says that "with this guarantee for the moral training of the pupils by precept and example on the part of the teachers, it seems to me that all is being done in that line that can be done," is he equally right? Is there not some moral taint, some poison-bearing germ from which such evils grow, lurking within these ethical influences? When we read of some great bank defalcation, of some much-trusted man absconding with fiduciary funds, and the like, in nine cases in ten the paragraph will end by stating that the perpetrator was a leader in a Sunday school, or a leading man in a church or a mission. Naturally we often ask why it is so. The usual and the easy answer is, that he put on the cloak of religion to screen and facilitate his dishonest methods—"the livery of heaven to serve the devil in." But that facile answer prompts another still more pertinent question, "Why did this professed religious man add hypocrisy to his other iniquities?" Must we not search the foundations of his ethical culture for the fruitful germ from which these evil actions sprang? It is more than probable that had any one of those leaders of a church or Sunday school, or of that majority of public-school teachers "of good standing in the various churches," confessed that he did not believe, or even that he doubted, that the world was made in six days some six thousand years ago; the first man molded from its clay, and the first woman from his newly made rib; that Moses conversed face to face with God; that Lot's wife was turned into a pillar of salt; that infants dying unbaptized are eternally damned; that the laws of nature were set aside when Christ was begot—he would have lost the position he held, and his social standing, as Dr. Robertson Smith, Dr. Woodrow, and many others have, for telling the truth. He was therefore reticent, and soothed his stultified conscience by saying to himself that, if those things were not literally true, they were in a figurative sense, and went on acting if not uttering a lie, as a very large class of people are doing every day for the same reasons. The teacher, preacher, or layman who does this is committing an immoral act, and preparing his conscience for tolerating others of a darker hue. We all know that it is the first willful lie or profane oath uttered that shocks the youthful conscience and sears it for repetitions that cease to shock. The late Henry Ward Beecher told us somewhere that his was so shocked at the first lie, that he sought the attic and behaved in such a peculiar, repentant manner that his mother questioned him, thinking that he was about to experience religion. Now the number of men and women who believe in the supernatural part of our religion is constantly growing less, yet for the reasons that I have alluded to they do not avow it. May it not be this constant acting of a lie that corrodes the conscience and causes, in a measure, the rapidly ascending degree of vice and crime, and the "venality and corruption pervading every branch of the Government"? Have we not reached that stage of enlightenment and that sound policy at which we can safely drop the supernatural from our religion, and relegate it to the cults of less advanced peoples, who still find it necessary to keep that element ingrafted into their theogonies, in order to awe their simple and unintelligent followers? We have outgrown the age of witchcraft which our Puritan ancestors believed in so fully, and we have denied the divine rights of kings, which had the same ethnic origin and for the same ends. Why not eliminate the same element in our religion, retaining all its sound ethical tenets, and administer it upon the human teachings of Christ and the natural laws that science has revealed in the progress of civilization? The time is rapidly approaching when the Bible will be expurgated, and all that science proves false expunged; the stirpiculture of its patristic writers and the foul genesis of Ammonite, Moabite, and Ishmaelite banished to the pages of a dead language, leaving a work that men can read without repulse, and the children in our public schools without pollution. As Mr. Meredith says, "Purify the fountain, and the stream will become likewise limpid and pure."

ADDISON CHILD.

CHILDWOLD, N. Y., *April* 8, 1890.

WHERE FLAX IS GROWN AND MANUFACTURED.

From *The Irish Textile Journal.*

UNDER this heading a correspondent in Boston sends us for verification the following cutting from a magazine article of recent date:

"The finest flax grown in the north of Ireland, in order to attain its highest quality, must be sent to Belgium to be steeped in the water of a certain river. Returning from there, it is spun into superfine yarns by the best machinery and in the naturally adapted moist climate of Belfast. At that stage the product is again sent back to Belgium, where it is woven into gossamer-like fabrics, in low, damp cellars, under conditions that would not be agreeable to the north of Ireland, and the work of the Belgian hand-loom weaver must then be carried back to be bleached under the dripping skies of the Green Isle."

The writer of the foregoing is a little mixed in his ideas. The finest flax comes to us from the Courtrai district, and the "certain river" in which it is steeped is the Lys, but no flax is sent from Ireland to be steeped there. Courtrai flax is used by our spinners for the finer counts of their yarns, chiefly for hand-loom linens; but these goods are not necessarily woven in low, damp cellars on the Continent any more than in the north of Ireland, where the finest goods can be made. Some descriptions of "gossamer-like" lace are made in damp cellars in France, and from hand-spun flax of the very finest quality, worth £180 to £200 per ton. Of course, we claim for Ireland that it possesses the best climate in the world for bleaching, but only a small quantity of foreign linen is sent here to be finished.

Editor Popular Science Monthly:

SIR: In reply to your esteemed favor of the 10th, received this morning, I have to say that while the object of the remarks quoted from the Irish Textile Journal apparently is to discredit or belittle the statements in the extract given from The Popular Science Monthly, it is the fact that these statements are only confirmed thereby in quite a remarkable manner. While, for instance, there may appear to be a contradiction in the point made by the Irish authority when he says that "no flax is sent from Ireland to be steeped" in Belgium—that is, at the present time—an examination of the text of The Popular Science Monthly will show that no statement on that subject is contained therein, and that it was not necessary to the argument. If the critic in question had been able to say that no Irish flax *had ever been* sent to Belgium for the specified purpose, or that no benefit would have been derived therefrom, then his remarks would have possessed a measure of weight and of justification that the mere fact of its being apparently for the moment, for undefined reasons, more advantageous to employ Belgian-grown flax does not confer upon them. The other comments made by the same journal require absolutely no reply, when it is borne in mind that the statements of The Popular Science Monthly article have reference only to the accomplishment of the highest possible excellence in a certain limited industry at a given period, and by no means can be held to apply to the production of Irish fine linen generally or permanently, or to other similar fabrics that may be produced in different parts of the world.

Yours very truly,

J. J. MENZIES.

220 SOUTH HILL STREET, LOS ANGELES, CAL., *April* 17, 1890.

A CENSUS OF HALLUCINATIONS.

Editor Popular Science Monthly:

SIR: May I ask for the publicity of your pages to aid me in procuring co-operation in a scientific investigation for which I am responsible? I refer to the Census of Hallucinations, which was begun several years ago by the Society for Psychical Research, and of which the International Congress of Experimental Psychology at Paris, last summer, assumed the future responsibility, naming a committee in each country to carry on the work.

The object of the inquiry is twofold: (1) To get a mass of facts about hallucinations which may serve as a basis for a scientific study of these phenomena; and (2) to ascertain approximately the *proportion of persons* who have had such experiences. Until the average frequency of hallucinations in the community is known, it can never be decided whether the so-called "veridical" hallucinations (visions or other "warnings" of the death, etc., of people at a distance), which are so frequently reported, are accidental coincidences or something more.

Some eight thousand or more persons in England, France, and the United States have already returned answers to the question which heads the census sheets, and which runs as follows:

"*Have you ever, when completely awake, had a vivid impression of seeing or being touched by a living being or inanimate object, or of hearing a voice; which impression, so far as you could discover, was not due to any external physical cause?*"

The Congress hopes that at its next meeting, in England in 1892, as many as fifty thousand answers may have been collected. It is obvious that, for the purely statistical inquiry, *the answer "No" is as important as the answer "Yes."*

I have been appointed to superintend the census in America, and I most earnestly bespeak the co-operation of any among your readers who may be actively interested in

the subject. It is clear that very many volunteer canvassers will be needed to secure success. Each census blank contains instructions to the collector and places for twenty-five names; and special blanks for the "Yes" cases are furnished in addition. I shall be most happy to supply these blanks to any one who will be good enough to make application for them to

Yours truly,

(Professor) William James,
Harvard University, Cambridge, Mass.

THE MYSTERIOUS MUSIC OF PASCAGOULA.

Editor Popular Science Monthly:

Sir: Mr. Chidsey's article upon The Mysterious Music of Pascagoula, in your April number, recalls a recent experience of mine. While cruising on the west coast of Florida, we lay at anchor one night at Rocky Point in Old Tampa Bay, and heard most distinctly a very curious musical note of some denizen of the water. The sound consisted of a single note, and was continuous for a long time. It recalled the singing of telegraph wires, or the hum of a planing-mill, or the music of an Æolian harp. It occasionally approached or receded, and more than one such note—apparently from different animals—could at times be heard at once. In our cabin the sound seemed very distinct, but it was in reality probably faint, as it was hardly, or not at all, audible upon deck. My companion and myself have both cruised along the Gulf coast south of that point before, but had never heard this sound anywhere else; our captain, also, had never heard it anywhere else, but said it was always to be heard at Rocky Point, which is a principal oystering-ground for Tampa. The sound bore no resemblance to that of the drum, which is very common in Florida, and which is a booming, interrupted noise. Its most remarkable peculiarity was its steady continuance—it certainly often lasted without interruption for several minutes.

Yours, etc., William M. Meigs.

216 South Third Street,
Philadelphia, *April* 16, 1890.

EDITOR'S TABLE.

A MORAL ISSUE.

TOO many of our friends, as we learn from letters that reach us from time to time, the position that The Popular Science Monthly takes up on political and economical questions appears more or less "one-sided." They would wish us, if we can not throw our influence on the side of paternal and protective government, at least to hold the scales even between that system and the anti-paternal, anti-protective system, to which manifestly our preference is given. We are sorry to disappoint any who find our pages sufficiently interesting to command their attention, but we do not see that we can abandon our present attitude. There is enough of trimming, enough of compromise, enough of the non-committal style of writing in the newspaper press: a magazine that professes to represent science may be pardoned for being true to what it conceives to be the teachings of science. What we are compelled to see in the restrictions that governments impose upon the course of trade is not a true statesmanship or a generous public policy, but simply a series of transactions, or, as they are now more familiarly called, "deals" with different private interests. Who can truthfully deny that this is the case? Certain manufacturers ask for protection and get it. What is their object in asking? Surely their own private gain. What do they ask? That other people may be forced to buy their goods, so long as the price is kept within a certain figure which is fixed far above the value of such goods in the markets of the world. Is this a righteous demand to make? It seems to us far from righteous. It seems to us that a man who approaches the Legislature with a request that the power may be conferred upon him by law to force his goods at a high price upon people who could buy, and would much prefer to buy, other goods at a lower price, comes forward with an essentially immoral proposition. But what if the people at large accept the proposition, it may be asked. What if they are willing to impose a heavy tax upon them-

selves in order that certain manufactures may be established in the country? We answer, that if the people were really willing to impose the tax upon themselves, there would be no need of the law. It is just because if the cheaper goods were accessible, everybody would buy them, that the applicant for "protection" seeks to tie the hands of the public. But we are not without positive information as to the relation of protection to politics. We know that in the highest political circles men who have had the tariff fixed to suit themselves are regarded as having received important personal favors. They have been put in the way of accumulating large stores of "fat" at the expense of the public, and if they are not forward in yielding up a little of the fat, when required, to help the party that framed the tariff so accommodatingly, indignant chairmen or secretaries of committees are apt to talk in a very menacing way about "frying the fat out of them."

The issue we see here is a moral one. Certain relations between the state and individuals are moral, natural, right. Certain other relations are abnormal, unnatural, wrong. Certain relations give rise to no evil; others are inseparable from evil. The protectionist *régime* is fruitful—can any candid man deny it?—in hypocrisy and fraud: hypocrisy on the part of those who, while solely intent on their own gain, make the most specious pretenses of patriotism and philanthropy; and fraud on the part of those who are led into attempts to evade a portion of the huge tax levied on the goods they import. The *régime* of non-interference would, in these two respects, lift a tremendous burden off the morals of the community. Who can pretend, in the face of known facts, that the relations between the seekers after protection and the tariff-makers are of a moral kind? How is it possible that we should have honest legislation, when interest after interest is constantly appealing for assistance or the continuance or increase of assistance, pledging itself tacitly if not expressly to return the favor when election-day comes round?

A well-known French economist, M. Courcelle-Seneuil, has lately expressed himself so vigorously and pointedly on this subject in the columns of the Nouvelle Revue, that we are tempted to quote one or two of his observations. Speaking of the common opinion that it is the business of government to promote the wealth of the community by special legislation, he says: "All inquiry in regard to this matter demonstrates: (1) That governments in general have no competence in questions of trade and industry of a nature to authorize them to regulate and control these departments of activity; (2) that the best means of enriching a nation is to leave its industry and commerce absolutely free; (3) that in interfering in commerce and industry the governing power can only transfer to one citizen the wealth of another, contrary to the very end of its institution, which is to maintain peace by justice. Justice consists in defending individual citizens against the violence or fraud which their fellows might otherwise exercise against them, while leaving to each as far as possible the conditions of existence natural to him as an inhabitant of the planet. The government could only favor a certain number by giving them what it had taken from the rest; in other words, by practicing the very thing which its business is to prevent—namely, injustice. . . . For example: I am carrying on an industry; I affirm that the nation has an interest in having that industry favored or 'protected,' as they say; I add that, if it is not protected, either by means of a bounty paid out of the public chest, or by a tariff that shall enable me to levy a tax upon consumers for my own benefit, I can not continue my business. One or other of the two affirmations may be false, and both commonly are. Nevertheless, the public are so accus-

tomed to be imposed upon by words, that both affirmations may be admitted without verification, particularly if they are maintained by persons of great wealth who go about in their carriages begging alms of other people. . . . Established for a quite different purpose, the government has no competence in industrial matters, and can only act therein upon the advice of others. *This advice is nearly always interested and unjust.*"

How entirely we concur in these remarks has already been indicated. If any one can show us that we are wrong in viewing this whole question in a moral light, and pronouncing for that theory of government which seems to us most favorable to public and private morality, we shall be prepared to consider it in other aspects, and listen with patience to the argumentations of those who would fain persuade us that restrictions on the activity and free initiative of individual citizens make for the strength and prosperity of the people as a whole, and that the national wealth is increased when goods are produced in the country at relatively high cost, which might be procured from abroad at relatively low cost.

The above remarks apply to tariff legislation, but individual liberty is abridged in many other ways that seem to us essentially wrong. That the members of a particular profession should have laws passed in their special interest, and should be empowered to decide who may and who may not enter into competition with them, is, we think, a violation at once of justice and of liberty. The worst of these things is, that a public motive is always alleged for what is in the main, if not exclusively, the outcome of private greed or jealousy. It would scarcely be too much to say that the most offensive forms of trade-unionism are found in connection with the so-called learned professions. Time was when it was supposed that the state had to look after the spiritual health of individuals; and for that purpose to prescribe their theological beliefs and religious observances. That belief has for the most part been exploded in the modern world, but its place has been taken by the notion that the state is responsible for the intellectual health of its members; and in lieu of the state church we have state schools. As regards the physical health of the community, the general method is to legalize one or two—possibly quite conflicting—schools of medicine, and to empower them to rule out, and if necessary to prosecute and punish, all others. Nobody, broadly speaking, seems to believe that, in the absence of all legislation of this character, people could in any adequate manner preserve their health or protect themselves against gross imposture. *We* believe it—believe it most heartily; and we believe that the science of medicine would advance far more rapidly, and that, on the whole, the public health would be far better, if every man were left perfectly free to employ any one he chose to attend him in sickness. At present every licensed practitioner feels himself authorized to call every unlicensed practitioner a quack. We should prefer a system under which, to a quickened public intelligence in questions of health and disease, the quack should stand revealed by his quackery. How much of real quackery is now concealed by the license to practice it might distress a confiding public to know.

Our voice may be as that of one crying in the wilderness, but we cry with conviction when we call for more individual liberty, with its correlative individual responsibility. There is something wrong, something vicious, in the application of compulsion where freedom of choice is indicated by all the natural conditions of the case. Force should be reserved for cases in which force is required, where nothing else will serve the purpose, and where the purpose is vital to the life of the society. In other cases the application of force is wrong. The issue of "Man *vs.* the

State" is a moral issue; and the more the question is looked at in that light, the more irrelevant, or at least unnecessary, other lines of argument will appear.

LITERARY NOTICES.

HYGIENE OF CHILDHOOD. By FRANCIS H. RANKIN, M. D. New York: D. Appleton & Co. Pp. 140. Price, 75 cents.

IN this little volume plain and practical advice is given in regard to taking care of the health of children, from about two and a half years of age to the completion of puberty. Among the subjects here treated which are liable to be carelessly regarded by parents are sleep, regularity of the bowels, care of the skin, and school hygiene. The author introduces also some observations on proper discipline—an essential in securing the child's obedience to the laws of health. The important subjects of food and clothing receive full consideration. Until very recently, as the author states, nearly half the mortality in our larger cities was of children under five years of age. When this is contrasted with the few deaths of children among people living in a state of nature, the wholesale manner in which civilized parents slaughter their offspring through ignorance and carelessness becomes evident. When Catlin went among the Indians he found that deaths of children under ten years of age were very rare: in one of the smaller tribes there had been only three in ten years; in the cemetery of another, where the bodies were placed above-ground on scaffolds, Catlin found only eleven bodies of children in one hundred and fifty. With the improvement of sanitary conditions in cities the death-rate of the children has decreased, and there is no doubt that with the spread of such knowledge as Dr. Rankin gives will come a still better showing.

ESSAYS OF AN AMERICANIST. By DANIEL G. BRINTON, A. M., M. D. Philadelphia: Porter & Coates. Pp. 489. Price, $3.

IN this volume Dr. Brinton has collected a considerable number of his essays and addresses read on various occasions, and published in the proceedings of the societies to which they were presented. These he has revised, and in many cases extended; and to them he has added several papers never before published. The special purpose which he designs the volume to serve is stated in the following words from his preface: "In a number of points, as for example in the antiquity of man upon this continent, in the specific distinction of an American race, in the generic similarity of its languages, in recognizing its mythology as often abstract and symbolic, in the phonetic character of some of its graphic methods, in believing that its tribes possessed considerable poetic feeling, in maintaining the absolute autochthony of their culture—in these and in many other points referred to in the following pages, I am at variance with most modern anthropologists; and these essays are to show, more fully and connectedly than could their separate publication, what are my grounds for such opinions." Dr. Brinton classifies these essays under four heads: ethnologic and archæologic, mythology and folk-lore, graphic systems and literature, linguistic. Their general range is indicated by the following titles, which are only a small part of the whole: A Review of the Data for the Study of the Prehistoric Chronology of America; On Palæoliths, American and other; The Sacred Names in Quiche Mythology; The Writing and Records of the Ancient Mayas; Native American Poetry; Some Characteristics of American Languages; and The Curious Hoax of the Taensa Language. In the essays on graphic systems a number of hieroglyphs are figured.

A DICTIONARY OF APPLIED CHEMISTRY. By Prof. T. E. THORPE, Ph. D., assisted by Eminent Contributors. In Three Volumes. Vol. I. London and New York: Longmans, Green & Co. Price, $15.

THE subject-matter of this work is pretty closely restricted to chemical technology and medicinal chemistry, space being allowed for purely scientific aspects of the science only when they have some direct bearing upon an art or manufacture. For all such matters the student is referred to the new edition of Watts's Dictionary of Chemistry, to which the present work may be regarded as complementary. In preparing the articles special attention has been paid to the bibliography of the subjects, and, in certain cases, to the

compilation of trustworthy patent-lists. Volume I goes from A to Dy. Among its chief articles are those on acetic acid, alcohol, alizarin and allied coloring matters, aluminium, ammonia, analysis, azo-coloring matters, bleaching, brewing, carbon, cements, chlorine, cyanides, dextrose, disinfectants, and dyeing. Under alizarin are given the history of the artificial production of this substance, the methods of preparing a large number of derivatives of anthraquinone, and accounts of the anthraquinone and dichloranthracene processes of manufacturing alizarin. The article on brewing comprises quite full consideration of the sources and chemical character of the water, barley, and hops used in making beer, with descriptions of the several steps in the process. Sixteen figures of brewing apparatus are given. In the article on cements, both building cements and adhesive cements are treated. Under the former division are included lime-burning, mortar, plaster of Paris, hydraulic mortar, pozzuolana, hydraulic cement, oxychloride cements, artificial stone, and concrete. Analyses of many of these substances are given in tables, and a bibliography of the subject is appended. Many of the articles involving descriptions of apparatus are fully illustrated. The more important ones are signed, and a list of contributors to the volume is prefixed, among which may be found many well-known names.

GEMS AND PRECIOUS STONES OF NORTH AMERICA. By GEORGE FREDERICK KUNZ. Illustrated with Eight Colored Plates and numerous Minor Engravings. New York: The Scientific Publishing Company. Pp. 336. Large 8vo. Price, $10.

MR. KUNZ has written a very interesting book, and it has been published in an elegant style. Nearly all the known varieties of precious stones occur in North America, and many of the American specimens have much beauty, but they are not found of such size and quality nor in sufficient quantity to rank them as an important product of the country. About one hundred thousand dollars' worth of precious stones, including pearls, are found in the United States yearly, but this is less than the value of the output from the diamond-mines of South Africa, or from our coal and iron mines, for a single day. The occurrence of diamonds in the United States, Mr. Kunz tells us, is chiefly confined to two belts of country: one along the eastern base of the Alleghanies, from Virginia to Georgia; the other along the western base of the Sierra Nevada and Cascade Ranges in Oregon and northern California. The Dewey diamond, found at Manchester, Va., in 1855, weighed before cutting 23¾ carats, and 11$\frac{11}{16}$ carats afterward. It passed through several hands, becoming the property of John A. Morrissey, who had made a loan of six thousand dollars on it. As it is off-color and imperfect, it is to-day worth not more than three or four hundred dollars. Mr. Kunz gives the history of the finding of a number of other American diamonds, many of which were picked up by children, or by persons knowing nothing of mineralogy. Some of these were destroyed by being struck with a hammer, their finders having an idea that this was a test which a diamond ought to stand. He also tells of reported finds of diamonds in which the stone turned out to be a quartz crystal which had been rolled among the gravel of some stream till it had acquired the appearance of a rough diamond.

Pieces of blue glass similarly worn into the shape of pebbles have been taken for sapphires. The largest crystal of sapphire ever found is in the Shepard mineral collection at Amherst College. It weighs three hundred and twelve pounds, is a perfectly terminated prism, partly red and partly blue in color, but opaque. It was obtained by Mr. C. W. Jenks from his mine at Franklin, N. C. In his chapter on the turquoise Mr. Kunz tells of its use by the ancient Mexicans, and by the Indians of the Southwestern United States, and gives pictures of several ornaments of their workmanship. He tells where the ruby, topaz, and emerald are found, and where occur a large number of less valuable stones, such as the garnet, tourmaline, beryl, amethyst, opal, agate, jasper, silicified wood, lapis lazuli, moonstone, sunstone, obsidian, amber, jet, cat's-eye, serpentine, malachite, and very many more whose names are less familiar. His account of Chalcedony Park in Arizona, where there are great blocks and whole tree-trunks turned to agate, is a very interesting portion of the book. There is also a remarkably attractive and fully illustrated chapter on pearls. The chief pearl-fishing grounds

of America are in the Gulf of California, but pearls are also found in shells of the unio, mussel, common clam, and other shell-fish all over the United States. Within one year they have been sent to the New York market from nearly every State in the Union. One worth five hundred dollars was found in Wisconsin in 1889, and others ranging in value up to three hundred dollars have been found in Vermont, Ohio, Texas, and Tennessee. The archæologist will be especially interested in the chapter on aboriginal lapidarian work in North America, and the general reader will obtain much welcome information from the concluding chapter dealing with imports, values, cutting of diamonds and other stones, mineral collections, and uses of precious and ornamental stones for silver articles and furniture and for interior house decoration. Mr. Kunz was eminently well fitted to produce this work, as he is the gem expert for Messrs. Tiffany & Co., has prepared several reports on the precious stones of the United States for the Geological Survey, and is the special agent in charge of this subject for the census of 1890. The magnificent plates showing all the important stones in their natural colors are the work of Messrs. Prang & Co., of Boston. The many other engravings show articles of aboriginal production, forms of crystals, etc. The book is of standard scientific value, giving as it does the mineralogical characters and chemical analyses of the stones treated, and its handsome form makes it worthy a place in the finest library.

FOOD IN HEALTH AND DISEASE. By J. BURNEY YEO, M. D., F. R. C. P. Philadelphia: Lea Brothers & Co. Pp. 583.

No one who examines this book can fail to be astonished at the amount of information that is here compressed within the limits of a small volume. Of course, the author has not put all that is known about dietetics between its covers, but he has gone over the ground with remarkable thoroughness. He describes the preparation, cooking, and preserving of food, tells the chemical composition and the special value of each of the common articles of food, the proper food for the individual at each period of life, from infancy to advanced age, tells how large numbers of persons may be fed cheaply and well, as in prisons, camps, and on board ship, and gives dietaries for all the principal diseases. "I have thought it desirable," says Dr. Yeo in his preface, "to enter fully and in detail into the important subjects of army and prison dietaries, school dietaries, and feeding during the critical period of infancy and childhood. In connection with the first of these subjects I have been at pains to present as fully as possible the admirable system of feeding our soldiers at home stations, so ably devised and carried out by Colonel C. J. Burnett—a system which may serve as a model of wholesome, economical, and intelligent feeding." Dr. Yeo gives a warning against the tendency to overfeeding in adults, especially those who habitually make little physical exertion. The habit of drinking milk with the meals is one way in which the proper amount of food may be exceeded inadvertently. In the part of the volume devoted to food in disease, besides general directions applicable to different diseases, there are given various "cures" known by the names of their originators. An appendix contains tables of hospital dietaries, and another contains a list of select recipes for invalids' dietary.

A NEW MEDICAL DICTIONARY. By GEORGE M. GOULD, M. D. Philadelphia: P. Blakiston, Son & Co. Pp. 519. Price, $3.25.

THE aim and scope of this work can be best told by quoting from the preface. The author's purpose has been "to include those new words and phrases created during the past ten years—a period rich in coinages—which appeared destined to continuous usage. . . . To frame all definitions by the direct aid of new, standard, and authoritative textbooks, instead of making a patchwork of mechanical copying from older vocabularies. While neglecting nothing of positive value, to omit obsolete words and those not pertinent to medicine except in a remote or factitious sense. To make a volume that will answer the needs of the medical student and busy practitioner, not only by its compactness of arrangement and conciseness of definitions, but also by its convenience of size and price." A notable feature of the work is its many tables, which comprise abbreviations, affixes, arteries, bacilli, ganglia, leucomaines, micrococci, muscles, nerves, plex-

uses, ptomaïnes, comparison of thermometers, weights and measures, mineral springs of the United States, and vital statistics. The article on mineral springs is by Judson Daland, M. D., and forms an appendix of thirty-two pages. At first sight the volume does not make a favorable impression, for its exterior is severely plain, and it appears to be printed from too small type; but very little examination is needed to show that the publishers' claims as to good paper, clear print, and binding so that the book will lie open at any page, are well founded.

HANDBOOK OF GEOLOGY, FOR THE USE OF CANADIAN STUDENTS. By Sir J. WILLIAM DAWSON, C. M. G., LL. D., F. R. S., Principal of McGill University. Montreal: Dawson Brothers. 1889. Pp. 250.

THIS is a practical treatise on geology, well fitted to the needs of those for whom it was written, more than half the volume being devoted to a review of the topography and geology of Canadian territory. It includes the results of the later geological surveys, the observations of Dr. G. M. Dawson in Manitoba and British Columbia in 1886–'87, and also the discoveries in paleontology which have changed the chronology of the *Blattidæ* and other species.

The work is divided into three parts. The first division treats of the constitution of rocks, their classification, the fossils found in them, and their arrangement. In classifying rocks, the distinction made between their origin, chemical nature, and texture is helpful. The second part relates to chronology. The nomenclature adopted by the International Congress is given, and the equivalent terms in use by geologists. The illustrations of the various eras, their fossil plants and animals, are well chosen and complete. The third and longest section is descriptive of the physical and geological features of the country. This is divided into six regions, and examination is made of each. The author does not give much space to the discussion of subjective theories, such as the origin of the metamorphism of rocks, the plasticity of the earth, and other mooted points; but refers to authors who have treated these subjects at length. Even in regard to the deposit of drift upon the plains by icebergs, he points out "difficulties in the way of the theory of glaciation caused by the absence of marine mollusca and other forms of marine life." As the area considered exceeds that of the United States, and representatives of nearly every period from Eozoic to modern times are found within its limits, it is evident that the student who becomes familiar with this rock-structure and history goes forth well equipped as a geologist. Directions are given for slicing rocks and fossils for the microscope, and a description of the tools necessary for the field geologist, with suggestions as to the best manner in which he may pursue his work.

A HISTORY OF MODERN EUROPE. By C. A. FYFFE, M. A. Vol. III, from 1848 to 1878. New York: Henry Holt & Co. Pp. 572. Price, $2.50.

IT is an important period which is covered by Mr. Fyffe's third volume, for during these thirty years many events took place whose influence in European history will be great and lasting. Among these are the creation of the Italian kingdom, the winning of the leading position among the German states by Prussia, and the war between France and Germany in 1870–'71. This period covers the greater part of Bismarck's active career, and includes the years in which Cavour and Disraeli made their fame. Soon after it began, occurred the Crimean War; the dismemberment of Poland was among its events, and it closes with the war between Russia and Turkey. The work is a record of wars and state-craft, and does not attempt to chronicle the progress of social, commercial, and industrial affairs. The book has large, clear print, topics are indicated by marginal titles, and there is a copious index.

THE WAY OUT OF AGNOSTICISM. By FRANCIS E. ABBOT, Ph. D. Boston: Little, Brown & Co. Pp. 75. Price, $1.

THIS little book is no more than a compact introduction to a treatise on scientific religion which Dr. Abbot is preparing. Agnosticism, he says, declares that the scientific method applies only to phenomena, to the appearances or shows of things, and has no possible application to noumena, or things as they really exist in their internal relations and constitutions. A scientific theology, Dr. Abbot maintains, will show that

the scientific method applies both to phenomena and noumena—both to things as they seem and things as they are. Agnosticism, destitute of the conception that God is immanent in nature, does not see that to know nature in any degree is to know God in precisely that degree. There is no unknowable, but simply the unknown or the imperfectly known. Against the relativity of knowledge as held by Herbert Spencer, he affirms that knowledge is based upon the internal self-relatedness of an object. This self-relatedness in its unity and constancy, as Kant observed, is the reason why all who judge an object come to agreement. Formulating the three types of real beings as machine, organism, and person, Dr. Abbot finds the universe to be all three. In the perfect intelligibility of the universe he places his hope for new light on the problems of immortality and duty, which shall be as certain and trustworthy as the light science has already cast on problems of physical nature.

THE ELEMENTS OF LABORATORY WORK. By A. G. EARL, M. A. London and New York: Longmans, Green & Co. Pp. 179. Price, $1.40.

TEXT-BOOKS adapted to the new and genuine method of science study are so few as yet that every progressive educator will welcome this addition to their number. The course which it embodies is designed as an introduction to all branches of natural science, its object being to teach a method of study rather than to convey information in a prescribed field. It is adapted to students in colleges and high-schools. To give an idea of the method of the book we quote the directions for the first exercise:

"*To find equal quantities of matter:* 1. Use a balance, and counterpoise two pieces of wood, cutting away one or the other with a knife until exact balance is obtained. 2. Counterpoise a piece of wood and a piece of lead. 3. Counterpoise another piece of wood with the lead, and then observe that the two pieces of wood counterpoised by the lead counterpoise one another.

"The above exercises show: 1. That with the same kind of matter, wood, the pieces which counterpoise each other are the same size, or thereabout; but different kinds of matter which counterpoise each other are not of the same size. 2. That two bodies counterpoise each other if they each counterpoise a third body, for these two bodies have been found to act alike under the same conditions—that is, when placed in the same position, and with all the surroundings the same. Two such pieces of matter are said to be *equal quantities of matter*, however unequal in size or different in appearance they may be."

Other exercises in weighing and some in measuring length and volume follow. While occupied with weighing, the student is directed to take to pieces a balance very carefully, the points in its construction which it is specially instructive for him to notice being stated. Observations of change of position, of changes of temperature, and of certain mutual changes common to all kinds of matter are among the early exercises of the course. A chapter is devoted to "observations of certain mutual changes exhibited by certain kinds of matter," namely, electrical phenomena. Under the head of "observations which lead to the theory that all matter is made up of very small separate particles" are embraced experiments on solution, diffusion, and the pressure of gases. A number of chemical experiments are given in a chapter devoted to "investigation of the composition of various kinds of matter." The final division comprises experiments in optics, designed to lead to the theory of the ether. An appendix gives many practical hints in regard to conducting the work in the laboratory. Lists of additional exercises and questions are inserted at the end of each chapter, and the text is illustrated with many figures of apparatus and diagrams.

Numbers Universalized is the latter or advanced part of the text-book of algebra by Prof. *David M. Sensenig* (Appleton, $1.25). The work is believed by its author to embrace all algebraic subjects usually taught in the preparatory and scientific schools and the colleges of this country. Part Second is divided into five chapters, as follows: one embracing serial functions, including, among other things, the binomial theorem, and exponential and logarithmic series; one treating of complex numbers, graphically and analytically; one embodying a discussion on the theory of functions; one

treating of the theory of equations, and one treating of determinants and probabilities, so far as the author deems these of interest and value to the general student. The volume closes with a supplementary discussion of continued fractions and theory of numbers. The two parts of the book are paged continuously, and may be had bound together.

Although prepared for English readers, the *Notes on American Schools and Training Colleges*, by *J. G. Fitch* (Macmillan, 60 cents), contains much that American teachers can read with profit. These Notes were made during a visit of the author to America in 1888, and were embodied in his annual official report on English Training Colleges, presented to Parliament in 1889. It is always instructive to see ourselves as other fair-minded observers see us, and this picture of our educational methods from a foreign point of view must help Americans to realize what are the peculiarities, the merits and defects, in a system all parts of which seem to us equally natural and admirable. An introduction has been prefixed to the volume telling how education is supported in England. This is a point on which many Americans appear to be ignorant, and a glaring case of such ignorance by a reverend writer in an American magazine is taken by Dr. Fitch as the text for his remarks. A table showing schemes of graded instruction in primary schools in England, New York, Philadelphia, Chicago, Massachusetts, and Ontario is inserted at the end of the volume.

Volume XI of the *Transactions of the Kansas Academy of Science* covers the annual meetings of 1887 and 1888. Most of the papers embody results of scientific researches on the geology, botany, and zoölogy of Kansas. Among these are Horizon of the Dacotah Lignite, by Prof. Robert Hay; On the Newly Discovered Salt Beds in Ellsworth County, by E. H. S. Bailey; Personal Observations upon the Flora of Kansas, by Mrs. A. L. Slosson; Geology of the Leavenworth Prospect Well, by E. Jameson; A List of the Kansas Species of Peronosporaceæ, by W. T. Swingle; and a Meteorological Summary for the Years 1887 and 1888, by Prof. F. H. Snow. There are also some papers on general subjects.

Prof. *Edwin S. Crawley*, of the University of Pennsylvania, has published a textbook entitled *Elements of Plane and Spherical Trigonometry* (Lippincott, $1), covering that part of the subject which is generally given in a college course. The first part of the subject is presented in much detail, with many examples and illustrations; further on the student is thrown more upon his own resources. In the preface, sections are specified which may be omitted without impairing the continuity of the text, if a shorter course is desired. An appendix contains the formulæ which the student will find most useful in subsequent work in mathematics. Answers to a part of the examples are given at the end of the book.

A fifth edition, revised and enlarged, of the little work on *Electric Light Installations and the Management of Accumulators*, by Sir *David Salomons*, Bart., has just been published (Van Nostrand, $1.50). The book is now more than twice as large as when it first appeared, having been extended to 334 pages, and contains 100 illustrations. The rapidity with which four editions have been disposed of, and the fact that the book has been translated into German and French, are practical indorsements of its value. Besides expanding the chapters of the last edition, the author has added two new ones, and many of the cuts are now inserted for the first time.

Prof. *R. H. Ward*, M. D., has published a revised edition of his record-book for botanical laboratory work entitled *Plant Organization* (Ginn & Co., 85 cents). The preface and introduction explain Prof. Ward's scheme of writing descriptions of plants; then follow twenty pages in which the terms commonly used in describing the parts of plants are defined. Here the author gives, in addition to many of the technical terms, simpler words that may be used by pupils whose course of study will be short. The leaves of the book are tied in by a cord, so that as each printed form is filled out it may be removed and handed to the teacher for examination. The forms, besides lines for descriptive words, have spaces for drawings. Blank pages are inserted, to which dried specimens may be attached.

A manual of hygiene entitled *How to preserve Health* has been prepared by *Louis Barkan*, M. D. (Exchange Printing Company,

New York). It contains advice on all the subjects usually comprised in a health manual grouped under two heads—the prevention of disease and the care of the sick. In the latter department are some directions which the layman is probably not expected to use himself, for, in another place, the author says that "so soon as unmistakable signs of disease are perceived, a physician should be called." The readableness of the volume has been increased by putting into it bits of description and accounts of ways and customs in other countries.

Mr. *Horatio Hale* publishes a *Manual of the Oregon Trade Language, or Chinook Jargon* (London: Whittaker, 3s.), written to form part of a volume of linguistics, the work of several contributors, which is not yet published. The author's first study of the subject was made in 1841, when, as a member of a United States exploring expedition, he undertook an account of the ethnology of the Oregon region. He found the jargon to comprise about two hundred and fifty words; the number had nearly doubled in 1863, when the dictionary of George Gibbs was published, since which time no material change seems to have been made in the language. In regard to the present volume, Mr. Hale says, in his prefatory note, "Comprising, as will be seen, a complete grammar and dictionary, with specimens of colloquial and narrative phrases, songs, hymns, a sermon, etc., it is intended to afford a manual for the use of travelers and settlers in the region where it is spoken, as well as an opportunity for philologists to study the construction of a genuine international speech now current, with the best results, among populations in various stages of civilization, speaking more than twenty distinct languages, and diffused over a territory nearly half as large as Europe."

A new solution to the problem of an international language is offered by *Augustin Knoflach* in a pamphlet entitled *Sound-English* (New York: Stechert, 25 cents). The author first sets forth the reasons why English is more desirable as an international speech than any artificial language, and asserts that the only obstacle to such use is its absurd, illogical spelling. He then illustrates some of the irregularities of English spelling, and answers the stock objections to any change in a vigorous and interesting style. In the second part of the pamphlet, Mr. Knoflach presents his method of writing English. It is a phonetic system, the deficiencies in our present alphabet being supplied by new letters. Long vowels are printed in heavy or full-face type. Besides giving the exact sound of each word, Sound-English also indicates the accent. Syllables containing long vowels are generally accented, so the full-face type is a mark of accent. Where this rule does not apply, a consonant is printed in full-face to mark the accent. All capitals are discarded; they are not needed at the beginning of sentences, and proper names are distinguished by the context, as in spoken language. One advantage claimed for this system is that type-writers can be easily modified to write it, the heavy letters being made by holding the space-bar and striking the key twice. An appendix in dialogue form answers objections to Sound-English.

A system of metrology designed to supersede the metric as well as the remaining old systems is set forth by the Hon. *Edward Noel*, in a book entitled *Natural Weights and Measures* (London: E. Stanford, 2s. 6d.). Its linear unit is an ell of about twenty-five inches, which is one ten-thousandth of the semi-diameter of the earth—the measure used by astronomers for expressing the immense celestial distances. The foot would be half an ell and would contain twelve new inches. All other measures and the weights would be derived from the linear unit, as in the metric system. They would be given the names now used for the old weights and measures. The proposed system differs from the metric in preferring duodecimal division in linear and weight measure, and binary division in surface and capacity measure. The author finds much to say in favor of the United Kingdom, the United States, and Russia adopting the "natural" system together, and he says it well. By description and in tables he presents the system from every point of view, and makes out a very able plea in its behalf, both on practical and on sentimental grounds.

Mary Boole, the author of *Logic taught by Love* (A. Mudge & Son, Printers, Boston), says of her own production: "This

book will seem to some a mere medley. Is it a text-book of logic, a pious exhortation, or a treatise on mythology?" The ordinary person will get exactly this impression from a first glance at the book; but he can not help feeling a respect for the author's mind from the fact that she realizes so well the character of her own work. It consists of a number of essays, dealing chiefly with metaphysics, the Hebrew religion, and educational methods. One object of the volume being to combat monotony and specialization in teaching, the chapters are far from being severely methodical in scope or arrangement. The author insists that too little regard is commonly paid to the bearing of different fields of knowledge upon each other. She makes many references to the work of George Boole, and frequently quotes from his Laws of Thought. Another of her authorities is Gratry, author of the Logique.

Æschines against Ctesiphon, edited by Prof. *Rufus B. Richardson* (Ginn), has been added to the College Series of Greek Authors. A life of Æschines is prefixed to the volume, and notes occupy about two thirds of each of the pages on which the text is printed. The book has a Greek index and an index of subjects.

A Report of Explorations in the Alleghany Region, made by Prof. *David Starr Jordan*, has been published by the United States Fish Commission. This examination had two general purposes: first, to ascertain the general character of the streams of the Alleghany region of Virginia, North Carolina, and Tennessee, and of western Indiana; their present stock of food-fishes, and their suitability for the introduction of species not now found there; second, to catalogue the fishes native to each stream, whether food-fishes or not, in order to complete our knowledge of the geographical distribution of each species, and to throw light on the laws which govern geographical distribution. The results of the observations recorded in this paper accord with a previous conviction of the author, that the question of distribution reduces itself to a question of barriers of various sorts. Each species extends its range in every direction, and holds the ground thus taken if it can.

The *Bulletin of the United States Fish Commission for* 1887 consists of reports and correspondence on a wide variety of topics. Among the more extended articles are reports on the fishes observed in Great Egg Harbor Bay, New Jersey, in 1887, and on the investigations by the schooner Grampus on the Southern mackerel-grounds, and a review of the mackerels of America and Europe (with plates). A fully illustrated paper of over one hundred pages, by J. W. Collins, describes the beam-trawl fishery of Great Britain. Among the articles of more popular interest are an account of the American Sardine Industry in 1886, by R. E. Earll and H. M. Smith; and The Aquarium: a Brief Exposition of its Principles and Management (illustrated), by William P. Seal.

An account of *The History of the Niagara River*, by *G. K. Gilbert*, included in the Report for 1889, of the Commissioners of the State Reservation at Niagara, has been reprinted in pamphlet form. It contains the substance of the lecture which the author gave before the American Association for the Advancement of Science, at its Toronto meeting in 1889, and is written in a style which makes it attractive to the generally intelligent person as well as interesting to the geologist. Mr. Gilbert discusses the changes of outlets of the Great Lakes caused by the advance and retreat of the ancient ice-sheet, and shows their bearing on the history of the Niagara River. He then describes the work of the cataract in cutting out its gorge, and concludes with a list of questions which must be considered before any satisfactory estimate of the rate of recession of the falls can be reached. The paper is illustrated with eight plates.

Three monographs by Mr. *Robert Ridgway*, published in the Proceedings of the United States National Museum, comprise a *Review of the Genus Xiphocolaptes of Lesson*, in which the existence of a much greater number of clearly defined forms than have been recognized by leading authorities was made apparent; a *Review of the Genus Sclerurus of Swainson*—in which several forms that had been "lumped together" had to be distinguished; and a *List of Birds* (sixty-six species) *collected on the Island of Santa Lucia, West Indies, Abrolhos Islands, Brazil, and at the Straits of Magellan, in* 1887–'88, by the Fish Commission steamer Albatross.

Among the later publications by the United States National Museum are descriptive *Notes of New Genera and Species* from the Lower Cambrian or Olenellus Zone of North America, by *Charles D. Walcott; New North American Aeridiдæ*, found north of the Mexican Boundary, by *Laurence Boemer;* description of *Two New Species of Snakes from California*, by *Leonhard Stejneger; Report on the Batrachians and Reptiles collected by the United States Fish Commission Steamer Albatross* in 1887–'88, by *E. D. Cope; Description of New Species of Fishes collected at the Galapagos Islands* and along the coast of the United States of Colombia during the same expedition, by *D. S. Jordan* and *C. H. Bollman;* and *Annotated Catalogue of Insects, collected by the Albatross in* 1887–'88, by *L. O. Howard.*

Two essays on *Primitive Architecture* have recently been published by *Barr Ferree.* In one, on Sociological Influences, reprinted from The American Naturalist, he tells how the form and arrangement of the dwelling have been modified according as the occupants were a single family or several families living in communism, as they were sedentary or nomadic, timid or warlike, etc. In the other, first published in the American Anthropologist, he takes Climatic Influences for his subject, and shows how they have affected the pitch of roofs, the size of windows, the closeness of walls, the choice of material, etc.

Mr. *Alfred R. Wolff* (New York) has published a pamphlet on *The Ventilation of Buildings*, in which he states the problem that the architect has to solve, correcting several popular misconceptions about ventilation, shows by what calculation the proper quantity of fresh air to be supplied to the inmates of a room may be found, and calls attention to the fact that efficient ventilation in cold weather involves additional expense in heating. He then considers several methods of obtaining the required supply and removal of air, and the relation of the usual methods of heating to ventilation.

The Second Annual Report of the Agricultural Experiment Station of Cornell University (published by the University, Ithaca, N. Y.) contains the reports of the several officers of the station, appended to which are Bulletins 5 to 15 inclusive, dealing with the production of lean meat in mature animals; whether heating milk affects the butter made from it; fodders and feeding-stuffs; influences of certain conditions upon the sprouting of seeds; wind-breaks in their relation to fruit-growing, tomatoes, deterioration of manure, etc. Many of the papers are illustrated.

The Fourth Reading-Book in Lippincott's New Series, by *Eben H. Davis* (Lippincott, 80 cents), is made up of selections in prose and verse from standand English and American authors, including some recent writers, whose works are drawn upon by permission of their publishers. A Chapter of Suggestions for Training the Voice is prefixed, and a list of questions for the use of teachers and a vocabulary are appended. The volume is illustrated.

A collection of *Heroic Ballads*, edited with notes by *D. H. Montgomery*, has just been issued (Ginn, 50 cents). The volume contains sixty-eight ballads, among which are many whose excellence has made them long popular, such as Macaulay's Horatius, Ivry, etc.; Aytoun's Execution of Montrose, and Edinburgh after Flodden; Marco Bozzaris, Casabianca, Lochinvar, Barbara Frietchie, Sheridan's Ride, and Curfew must not ring To-night. Others less familiar are Cowper's Boadicea, Scotland's Maiden Martyr, Shan Van Vocht, Song of Marion's Men, The Song of the Camp, and Lowell's Commemoration Ode. Explanatory notes are introduced at the foot of the pages, and indexes to these notes and to the authors represented are appended to the volume.

A very full treatise on whist, entitled *American Whist Illustrated*, has been written by *G. W. P.*, the author of American Whist and Whist Universal (Houghton, $1.75). He states that this publication is a digest of his two previous volumes, with all the amendments, revisions, and changes in play required by the application of recent inventions and improvements in the practice of the American game. The volume is introduced by a short history of cards, including the game of modern whist; then follow the laws of American whist and the rules of a Boston whist club—the Deschapelles. In his rules for original leads and his analyses of the play of second, third, and fourth hands, the author is liberal with reasons and

explanations. The characteristics of American Leads and of "The New Play" are fully explained and illustrated, and due attention is given to a large number of special topics. A chapter of some sixty pages on Whist Practice consists of rules and counsel designed to stimulate the indifferent player to become a good one. A sample conversation, such as is carried on by four persons of the former sort, is also introduced. Twenty illustrative hands, with figures of all the cards, conclude the volume.

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POPULAR MISCELLANY.

Geological Survey-Work in Minnesota.—The law of 1872, under which the Geological Survey of Minnesota was instituted, was intended, according to Prof. N. H. Winchell, to place the survey in close connection with the State University; and the professorship of Geology and Mineralogy in the university was maintained for six years at the expense of the survey fund. From it the museum of the university has obtained the nucleuses of growing geological, zoölogical, and archæological collections. The survey was supported by legislative appropriations till the revenue from the sale of salt-springs lands supplied their place. The economic side of the enterprise has been kept in mind constantly, though it has not been conspicuous. "The annual reports embody common facts, and description cast in a semi-scientific mold. They are addressed primarily to a home constituency, in order to show them the utility of the work of the survey. As the survey becomes grounded in the good-will of our own citizens, it is strengthened for doing more advanced work, and at the same time finds a constituency that is ready to welcome more strictly scientific publications." Among the most important results of the work of the survey have been the saving of the salt-springs lands from being devoured by speculative enterprises; dissuading citizens, by the publication of correct information on the subject, from making fruitless searches for coal; calling attention to the economic resources of the State; and showing the people how to secure cheaply a supply of pure water for domestic purposes. The scientific results, while not including any great new discoveries, have been numerous, and all have a place in the elucidation of geological theory. The unfinished work of the survey lies in the northern part of the State, and, embracing the crystalline rocks and the various questions of economic and technical geology that pertain to them, is the most important as well as the most difficult and costly part of its work.

Summer Courses at Harvard.—The courses of summer instruction at Harvard University will include four courses in chemistry (general elementary chemistry, qualitative analysis, quantitative analysis, and organic chemistry); courses in experimental physics and botany, geology (elementary and advanced); topography, French, German, and physical training; and courses at the medical school. A general course of lectures on methods of instruction will be given in addition by teachers in the several departments represented by the schools, open free to all members of the summer schools. Persons are admitted as special students in the university who desire to pursue for a year or more the study of some particular subject; and who, having received a high-school or academy training, wish to follow for one or more years a course of liberal study preparatory to some profession or to the walks of active life. The summer courses will open on different days between June 30th and July 9th, inclusive.

Nature's Earth-Carving.—As the tools used by Nature in carving the earth, Dr. Archibald Geikie enumerates air, rain, rivers, springs, and frost. Exposure to the air changes the hardest rocks. Cracks form in them which receive the rain and are enlarged by freezing in winter, to increase the effect of the next season's rain in washing away the surface. No rock wears away faster than white marble, the destruction of which is speeded by the carbonic acid in the air. The waste in a century sometimes amounts to a third of an inch in thickness. The more compact kinds of sandstone endure better, and in tombstones still, after the lapse of two centuries, show marks of the chisel. Sandstones, however, usually con-

tain a layer more soluble than the rest, along which the rock splits and peels. Compact rocks like granite are traversed by parallel joints on which the weather acts destructively; and the less compact clays, dried to powder, are blown by the wind and swept more rapidly into rivers, lakes, and the sea. The rain-streams, always running over the same channels, furrow the hill-side and wear it away still more rapidly; and a sheep-walk in a few years may become a deep ravine. The material carried down, when spread at lower levels, helps to form plains like meadows, and these in time may be cut through and partially carried away. Streams descending from peaty regions are charged with carbonic acid, and destructive to limestone. In all mountain regions the rivers are liable to enormous increase in volume from heavy rainfalls, when they carry off proportionately larger quantities of earth. The work of springs is like that of rain and rivers. The sink-holes in limestone regions carry the water down underground to do a similar work there; and this underground flow of water often helps in the production of land-slips, especially when the ground is covered with bowlder-clay.

Teaching the "New Botany."—In the "New Botany," as described by Prof. W. J. Beal, in Garden and Forest, pupils are set to studying plants before books. Previous to the first lesson, "each pupil is furnished or told where to procure some specimen for study. If it is winter, and flowers or growing plants can not be had, give each a branch of a tree or shrub, which may be two feet long. The examination of these is made during the usual time for preparing lessons, and not while the class is before the teacher. For the first recitation each is to tell what he has discovered. The specimens are not in sight during the recitation. In learning the lesson, books are not used; for, if they are used, no books will contain a quarter of what the pupil can see for himself. If there is time, each member of the class is allowed a chance to mention anything not named by any of the rest. The pupils are not told what they can see for themselves. An effort is made to keep them working after something which they have not yet discovered. If two members disagree on any point, on the next day, after further study, they are requested to bring in all the proofs they can, to sustain their different conclusions. Give other specimens for the next lesson, keep reviewing, and generalize as details and facts accumulate. I like to give two species for careful comparison. . . . After a few weeks, reviews may be made in connection with chapters in some book. I make it a rule to give pupils specimens for study and comparison regarding every chapter in Gray's Structural Botany before the book-lesson is studied. I place no stress on making these investigations in the order in which the chapters of a text-book are arranged. Free use is made of our botanic garden, the crops in the vegetable-garden, fields, and experiment station, and the thickets along the river. Special topics are often assigned, in which each student has to go many times to observe and record observations on his growing plant." Illustrations by drawing are a prominent feature of the whole course.

Leaning Towers.—The leaning tower of Pisa is not the only building of its kind. There are many towers in northern Italy that deviate from the perpendicular, so that a writer has spoken of the country as "a land of towers staggering in all directions like tipsy men"; and there are in England few spires of any great altitude that are quite upright. The inclination of the Italian towers is a result of the character of the foundation soil, and of mistakes in building. The soil and subsoil of northern Italy down to the water-level are composed of rounded stones brought down by torrents and rivers from the Alps. A broad foundation is a primary condition of the stability of buildings erected upon it. The builders of the towers had classic models in their eyes, and did not contemplate the broadening of bases or the adding of buttresses to insure stability. Consulting appearances, and not venturing to depart from the conventional, they built straight up. The pressure concentrated on the narrow base was too much for the shifting stones beneath. They yielded at the weaker points, and the towers bent over. If the builders had minded the example of their Gothic neighbors and widened their bases, the load would have been more evenly

distributed over more ground, and the deviation from the perpendicular would not have been so obvious. There are many leaning towers in Bologna, inclining in all directions; and few of the campaniles of Venice are perfectly upright.

Palæolithic Implements in the United States.—The Palæolithic implements of the District of Columbia, and indeed from all over the United States, as described by Mr. Thomas Wilson, are always chipped, never polished; are almond-shaped, oval, or sometimes approaching a circle; have their cutting edge at or toward the smaller end, and not, as in the Neolithic specimens, toward the broad end; are frequently made of pebbles, and with the original surface sometimes left unworked in places; and are exceedingly thick compared with their width, so much so as to make it apparent that they were never intended to have a shaft or handle after the fashion of the axe or arrow or spear-head. They were usually made of quartz, quartzite, or argillite; while the Neolithic man used any material that would grind to a smooth surface. They are not known to have been used by the American Indian, who when found by Europeans was in the Neolithic stage. Of the thousands of Indian mounds, cemeteries, graves, and monuments which have been explored, not one has ever yielded these Palæolithic implements. The articles found in the District of Columbia are of the same type as Palæolithic implements found in the Trenton gravels; at Little Falls, Minn.; in Jackson County, Ind.; at Claymount, Del.; and at Loveland, Ohio; and all together contribute to prove that a real Palæolithic period existed in the United States.

Sharing of Earnings.—After several years of experimenting, Mr. Alfred Dolge, of Dolgeville, Herkimer County, New York, has decided upon a plan for sharing with his employés the earnings of his manufacturing business. A share of the net earnings of the business is to be set aside each year, and applied for the benefit of the employés in three ways—as pensions, insurance, and endowment. Every male employé who becomes unable to work after a continuous service of ten years receives a pension equal to fifty per cent of his wages. Each three years of service over ten up to twenty-five, increases the pension ten per cent. A disabling accident happening to an employé while on duty entitles him to a fifty-per-cent pension, even if he has not served ten years. Employés are also entitled to a life-insurance policy for one thousand dollars after five years' service, to a second one after ten years, and a third after fifteen years. For each employé rejected by the insurance company with which the house contracts, and for those entering the service of the house when over forty years old, thirty-five dollars a year is deposited instead of the policy. After five years of consecutive service, also, an account is opened with each employé, upon which he will be credited at the end of each year according as the manufacturing record shows that he has earned more than has been paid him in the form of wages. If through gross carelessness any employé has caused the house a loss, such loss will be charged against this account. This endowment money shall be payable when the employé reaches the age of sixty years, or upon his death. Against this account the employé may obtain a loan by paying interest and furnishing collateral security. Mr. Dolge is convinced that this scheme is superior to what is known as profit-sharing, because it is not projected from any idea of benevolence, but is based on self-interest. It places the employé on the same level with his employer; it puts him on his mettle, and rewards him according to his own merit. The main objection which Mr. Dolge has to the ordinary profit-sharing plan is that it gives the lazy and incompetent workman the same percentage in addition to his wages as it gives to the intelligent and industrious employé, who has perhaps earned for his employer twice as much as the former.

Science and Poetry.—Writing upon Browning's Science in Poet Lore, Dr. Edward Berdoe maintains that, "other things being equal, the poet who knows his natural history, his botany, and his physical science, will write better poetry than he who knows nothing of these things." The author has for some years been pointing out how Browning's scientific imagination and learning enhance the value of his poetic work and his

claims to recognition as a great teacher of the nineteenth century. His work is "as distinctively the product of the age of science as Petrarch's of the revival of learning." There is not a mood of the human mind, Dr. Berdoe continues, which is beyond the power of this poet to analyze and explain. "Analysis with him becomes invective. He is 'the maker,' because he is so great an analyst. Analysis with genius such as his leads to synthesis, and for this he is called a scientific poet." His poems teem with instances of the influence which modern scientific discoveries have exercised upon his genius, and this possibly is one element in their obscurity. As Max Müller has said that neither Tennyson nor Browning could be understood without an acquaintance with the Greek and Roman classics, so "in Browning's case a knowledge of the physical sciences is also demanded of us; but this only shows that Browning is in advance of his time, as a leader of men should be. The age can not be very distant when an acquaintance with science will be as common as a knowledge of the ancient classics. Then we shall hear less of Browning's obscurity. Browning's theory of life is eminently in accord with the teachings of evolution and development." It is scientific because he goes into its purpose, and what to the pessimist is infinite mystery is replete with law and order to him. A large number of citations from Browning's poems are given to confirm and illustrate these positions.

Recognition of Pictures by Animals.—A correspondent of The Spectator owns a fox-terrier that had been cured of a tendency to run sheep by judicious punishment. Some time afterward the dog, which had been left in a room for a few minutes with an unfinished painting of sheep and sheep-dogs in the snow, was found gazing intently at the picture and showing all the signs of canine excitement. As the figures of the sheep were only eight or ten inches in length, the owner believed that the dog must have understood that they were supposed to be at a distance from him. The dogs in the picture he apparently entirely ignored. Another correspondent of the same journal tells of a dog who, when shown a life-sized figure of a cat worked in wools on a screen, made a rush for it, and but for his master's clutching him firmly by the collar the screen would have been torn to shreds. A cat is also mentioned who sprang at a bird which her mistress had painted on a fire-screen, and a dog, who disliked being washed, that when shown a large picture of a child scrubbing a fox-terrier in a tub turned away his head ruefully and would not look at his "brother in adversity." These instances are put forward as evidence of animal intelligence. But do they not rather serve as measures of the inferiority of brute to human intelligence? For the dog or cat in each case was deceived by an artificial representation on the flat which would not deceive a human being.

Antiquity of Submarine Warfare.—The efficiency of submarine mines or batteries and of guard-boats and shore defenses is augmented to a wonderful degree when the two systems are made to supplement one another. The combination of them affords the only means now known for compelling the enemy to long and cautious operations when he would like to carry his purpose at a blow. It is possible to evade or defy either system alone, but "even the most dashing commander would hesitate to run past forts and batteries when every channel is alive with destructive charges." The efficiency of mines depends on every part of their arrangement being complete; and while the laying of them is simple enough, they are in practice subject to difficulties and complications from weather, wind, tides, currents, fogs, and shifting ground, that can not be foreseen. These cunning inventions of explosive engines, rams, and torpedoes, though they seem so new and scientific, had their counterparts in the devices of the past. The spar torpedo-boats were like the Greek fire-boats which were described in the thirteenth century as old. The mobile torpedo-boat had its prototype in those drifting or secretly propelled infernal machines that figured in the water-fights of two or three hundred years ago. Fixed submarine mines were described by Gianbaptista Porta in 1608. The principles of these systems are old; all that is new in them is contained in the "modern improvements" and more perfect adaptations. The systematic application of submarine warfare, however, dates from the second half of

this century. Louis XIV would have nothing to do with it. Napoleon discouraged Fulton's efforts, because they favored the art of defense as against his offensive operations; and in England Pitt was blamed for experimenting with Fulton's devices because it was encouraging a mode of warfare which, if successful, would be destructive to English supremacy of the seas.

Astronomy on Lake Tanganyika.—According to Père Vyncke, a French missionary, the negroes on the western side of Lake Tanganyika, although the sun passes over their heads twice a year, take no notice of his course, and have no idea of the solar year; but the moon plays an important part in their life. They celebrate its renewing by beating drums, firing shots, and shouting. The new moon is hailed with general dances by most of the African tribes. To keep the run of its age they have a bundle of twenty-eight or thirty sticks, of which they take out one each day. They consult the stars to determine the times for agricultural work, fishing, etc. The rising of the Pleiades marks the sowing season, and is celebrated by dances and festivals in honor of the dead; and the constellation is called *kili*, or seeds. The milky way is called the line of drought and rain, because the rainy season begins when it rises at sunset. The rising of Orion's belt gives the time for catching a certain fish. Another star, which Père Vyncke does not identify, is called by a name signifying pounding manioc, because that operation is begun when it is at the zenith. Aldebaran is called the Northern and Sirius the Southern Gem. The Centaur, the Southern Cross, and the Ship, including the beautiful star Canopus, which is not visible in the north, are called by names signifying "paths" and "tens," because they point the way to the south pole and are composed of a large number of stars.

Voracity of a Pike.—The following story is told by a correspondent of Land and Water: "I and some friends were fishing in a small river in Hertfordshire, and, sport being poor, were watching a family of moorhens, just hatched. One of the fledglings, venturing too far out, was carried down a swift run, but managed to paddle into an eddy. No sooner, however, was the little creature in this supposed haven of refuge, than there was a swirling movement from below, a quick snap, and the fledgling disappeared in the jaws of a pike. Later on a second chick got carried away and was also swallowed by the pike, and very soon afterward, in spite of one rescue on our parts, a third was sacrificed. This was more than we could stand, and a spinning minnow, very poorly adapted for pike-fishing, was produced. At the second cast the lure was taken, and, fate being propitious, the gut escaped the pike's sharp teeth. Result, a fish of four pounds only. When landed, the last-taken chick fell out of the pike's mouth with an expiring gasp still in it, and, on the fish being held head downward and shaken, the other two made their appearance."

The Ordeal by chewing Rice.—The East Indian method of discovering a thief by the ordeal of chewing dry pounded rice has almost disappeared of late. A case of its successful application many years ago, to discover who had stolen a gold watch that was missing, is described in Chambers's Journal. A native official, who was employed by the government for detecting thieves by the rice ordeal, was called in to conduct the process. The loser of the watch was one of four young Englishmen who occupied a house together. All the servants of the establishment, some forty-odd in number, were seated in two rows on the ground in one of the long verandas of the house. A small piece of green plantain-leaf was first placed in each man's hands. The thief-detector then went round with a bowl of pounded rice, like flour, and with a wooden spoon poured a quantity into the open mouth of each servant. The order was given that each man was, within five minutes, to chew the rice-flour to a pasty mass, and eject it on to his plantain-leaf. Most of the men set to work with a will, though a few were rather frightened at first; but long before the five minutes had elapsed almost every one had got through with the operation, and held the evidence of his innocence in his hands. But why are so many eyes turned toward one man, who sits back as if anxious to avoid observation? We also look, and there is the favorite serv-

ant of the loser of the watch, with his face almost convulsed, and trying in vain to get the rice-flour out of his mouth. His lips are dry, and his glands refuse to produce the saliva which is needed to moisten the rice-flour. At last the detector's eyes glare upon him, and pointing at him with his long, bony finger, he says solemnly, "There is the thief!" The victim quails and grovels on the floor before him; he faintly appeals to his master for forgiveness, and promises that he will restore the watch. The convicted thief slowly rises, and requesting his master to follow him, goes to the well in the garden, and produces the gold watch from under a loose brick. This operation savors of magic, but it has a psycho-physiological explanation. It is one of the instances of the influence of mind over body: the anxiety of the culprit evidently arresting the flow from the salivary glands.

Position of the Expert Witness.—The expert, the Chemical News has said, occupies an anomalous position in court. Technically, he is a mere witness; practically, he is something between a witness and an advocate, sharing the responsibilities of both, but without the privileges of the latter. He has to instruct counsel before the trial and to prompt him during its course. But in cross-examination he is the more open to insult, because the court does not see clearly how he arrives at his conclusions, and suspects whatever it does not understand. Hence, not a few of the most eminent men in every department of science distinctly and peremptorily refuse to be mixed up in any affair which may expose them to cross-examination. "I will investigate the matter, if you wish it, and will give you a report for your guidance, but only on the distinct understanding that I am not to enter the witness-box." Such in substance is the decision of not a few men of the highest reputation and the most sterling integrity. Certainly it is not for the interests of justice to render it impossible for such men to give the court the benefit of their knowledge. Further, the spectacle of two men of standing contradicting or seeming to contradict each other, in the interest of their respective clients, is a grave scandal. Thus, our present mode of dealing with scientific evidence is found on all hands unsatisfactory. The outside public is scandalized; experts are indignant; and the bench and the bar share this feeling, but are disposed to blame the individual rather than condemn the system. It was proposed, as a remedy for this evil, that "the expert should be the adviser of the court, no longer acting in the interest of either party. Above all things, he must be exempt from cross-examination. His evidence, or rather his conclusions, should be given in writing, and accepted just as are the decisions of the bench on points of law."

Half a Century of Inventions.—"Those of us not yet fifty years of age have probably lived in the most important and intellectually progressive period of human history," says Iron, and names the following as a few of the inventions and discoveries which have originated or been made practical within the past half-century: Ocean steamships, railways, street-car lines, the telegraph, ocean cable, telephone, phonograph; photography, and a score of new methods of picture-making; aniline colors, kerosene, electric lights, steam fire-engines, chemical fire-extinguishers; anæsthetics and painless surgery; gun-cotton, nitroglycerin, dynamite, and a host of other explosives; aluminum, magnesium, and other new metals; electro-plating, spectrum analysis, and the spectroscope; audiphone, pneumatic tubes, electric motors, electric railways, electric bells, type-writers, steam heating, steam and hydraulic elevators, vestibule cars, cantilever bridges. To these may be added the vulcanizing of rubber, the Bessemer steel process, bicycles, the "Monitor" type of war-vessels, the dynamite gun, and doubtless the list does not now include all of the most important even.

Science in the Laundry.—While washing is declared to be as much a chemical process as dyeing or pattern-printing, there has been very little application of scientific principles to it. The finishing up is held in the laundries to be more important, but is really less so than the preliminary processes of actual cleansing. These are four in number—digesting or soaking, washing, rinsing, and drying. In cleansing, two sources of contamination are to be kept in view—the dirt that comes from without and settles on the

clothes, and the soiling that is caused by transpiration from the body. It is most important that the elements of bodily soil be removed, and this is probably accomplished quite as much in the drying as in the washing. We judge of the purity of clothes by their "sweetness." This is, to a large extent, proportioned to the completeness with which they have been acted upon by the atmosphere, or by its great oxidizing agent ozone, and is consequently dependent on the atmospheric conditions under which they are dried. The lesson is, that atmospheric drying is the best, and that laundry drying by artificial heat can not be depended upon to do its work, unless pains are taken to give a free circulation of ozonized air.

Voice-Figures on Glass.—A curious mode of decorating glass is practiced by an English lady, Mrs. Watts Hughes. The figures which she produces are shell-like forms, trumpet and snake like shapes, twisted together and combined, and crossed in various directions by lines, but not exactly like anything in nature. The instrument by which these lines are drawn is the voice, and the method of procedure differs for different figures. For a daisy-like figure, Mrs. Hughes prepares a paste of flake-white powder-color and water. On a thin membrane of India-rubber stretched over one end of a ring, resembling a napkin-ring, she spreads a little water, to which some of the flake-white paste is added, and thus floated all over the disk. This ring is inserted into the lower end of a tube turned up like the letter J. She then sings into the upper end of the tube a low note, firm but not very loud. Tiny globules of the paste are thrown up into the air by the vibration of the membrane induced by the sound, and fall back upon the center of the disk, making a little round heap, like the center of a daisy. Mrs. Hughes then sings a note of a different character from the first, when from the round center of white paste will fly out, at unequal distances, little tentative star-like jets. Sometimes two or three abortive attempts will have been made, when suddenly a symmetrical row of petals will start out and create with the center a dainty daisy-like figure. The pansy form is produced somewhat in the same way as the daisy, but more water is put on the disk in proportion to the paste, and the note is sung differently. In singing the shell and trumpet figures, the paste is made with Prussian blue, madder lake, or other pigment whose weight and character suit it to the vibrations of the particular note to be sung. Glass is rubbed over with the paste when the figures are to be called out upon it as well as the membrane. With a small piece of glass, Mrs. Hughes uses a bent-up tube and moves the glass rapidly round on the disk. Should the glass be too large to hold in the hand, she uses a straight tube, and sings the note while moving it round or along the glass. Specimens of this work were shown in the "Arts and Crafts Exhibition," at London, last fall, and panes decorated in this way form the lower part of the windows in Mrs. Hughes's Home for Little Boys, at Islington. The explanation of the phenomenon is that the particles of coloring-matter are thrown off from the vibrating parts of the membrane and collect on the nodal lines—the lines of no vibration. The nodal lines of vibrating membranes were first thoroughly studied by Savart.

Taming the Puma.—To show what may be done in the way of training the puma, or Rocky Mountain lion, usually deemed one of the most intractable of animals, William Lant Carpenter writes to "Nature" an account of one he has recently seen at Livingston, Montana. She is now three years old, and was raised from a cub by Mr. W. F. Wittich, who devoted eighteen months to training her. He now has her under complete control. "The beast not having been fed for twenty-four hours, he trailed pieces of raw meat over her nose and mouth, which the puma never attempted to eat until the word was given, as to a dog. Occasional attempts were made, but a twist of the ear by Mr. Wittich was sufficient to control her. When meat was placed a few yards off, the puma fetched it by word of command, and permitted the meat to be taken from her mouth by Mr. Wittich, who fondled her as he would a cat. A very fine dog, a cross between a pure setter and a pure St. Bernard, five years old, named 'Bruce,' is on intimate and even affectionate terms with the puma, who allowed him to remove meat

placed upon her jaws, and to eat it. On one occasion the puma (who is often allowed to range the house), the dog, and Mr. Wittich slept together in the same bed. . . . In training her he has chiefly used the whip, which she feels only on the nose, ear, and under the tail; he assures me he has made his own teeth meet through her skin in several other parts of her body without her showing any signs of sensation. Her memory is short, and three weeks' intermission of the performance necessitates much extra training and trouble."

Beet-Sugar in Germany.—Baron Lucius's report on the crisis in the beet-sugar industry of Germany, from 1884 to 1887, brings out the curious fact that the largest number of roots were used in the manufacture of sugar during 1884–'85, when the crisis was most intense. This is accounted for by the fact that preparations for extending the manufacture and the cultivation of the roots had been made before prices declined. The increase was also promoted by the general adoption of the processes of diffusion, and the production of a beet-root richer in saccharine matter. The production of molasses was also considerably increased. The Germans are estimated to consume eight kilogrammes of sugar per head; and the exports have increased in greater proportion than the production.

NOTES.

Prof. Samuel Cushman, Apiarist of the Rhode Island Agricultural Experiment Station, maintains, as the result of personal observation, that bees do no damage to growing or fair fruit. The juice of fruit is, in fact, injurious to them; and they do not attack sound fruit, but only bruised fruit, or that which has been previously injured by other insects. Every member present of the State Horticultural Society, before which Prof. Cushman read his paper, sustained him in this view. The author spoke also of the useful agency of insects, particularly of bees, in aiding the fertilization of flowers, and in contributing to cross-fertilization.

In Prof. John Bach McMaster's course of instruction in the history of the United States in the University of Pennsylvania, text-books are eschewed, and lectures and a printed syllabus take their place. Students are referred, whenever it is possible, to printed documents for information; and maps and diagrams, prepared by the members of the classes, are required to accompany the theses.

The Royal Geographical Society has awarded its Royal Medals to Emin Pasha and to Lieutenant Younghusband—to the latter, for his journey from Manchuria over the Mustagh Pass to Cashmere and India, of which we have published an account; the Cuthbert Peek grant to Mr. E. C. Hare, for observations on the physical geography of Lake Tanganyika; the Murchison grant to Signor Vittoria Sella, in consideration of his recent journey in the Caucasus; and the Gill memorial to Mr. C. M. Woodford, for his expeditions to the Solomon Islands, of which a report has been published in the Monthly.

Extract from Stephen Girard's will, dated February 16, 1830, in his eighty-first year: "The orphans admitted into the college shall be instructed in the various branches of a sound education, comprehending reading, writing, grammar, arithmetic, navigation, geography, surveying, practical mathematics, astronomy; natural, chemical, and experimental philosophy, the French and Spanish languages (I do not forbid, but I do not recommend, the Greek and Latin languages), and such other learning and science as the capacities of the several scholars may merit or warrant. *I would have them taught facts and things, rather than words or signs;* and especially I desire that by every proper means a pure attachment to our republican institutions and to the sacred rights of conscience, as guaranteed by our happy constitutions, shall be formed and fostered in the minds of the scholars." It is interesting to see how distinctly this notably clear-headed man set forth the requirements of a real education, which are only beginning to be adopted sixty years after he penned these words.

In the opinion of Sir T. Spencer Wells, President of an English Sanitary Association, much of the outcry about dangers from women taking up men's work is breath wasted. He thinks women capable of a great deal more than they have been accustomed to do in times past. "If overwork sometimes leads to disease, it is more morally wholesome to work into it than to lounge into it." For every example of disease of mind or body induced by mental overstrain he has seen twenty "where evils equally to be deplored are caused in young women by want of mental occupation, by deficient exercise, too luxurious living, and too much amusement or excitement."

Movements for the abolition of war are likely to gather increasing strength from the growing and universal expensiveness of the system. In the middle ages but little harm was done by war, except to the fighters. If a territory was overrun and devastated, there

was but little fixed capital to be damaged, and the next year's production of the soil would be as good as ever. But the effects of to-day's wars in civilized countries are felt, not by the belligerents only, but to the very ends of the earth. The network of commerce is so complicated and extensive that any suffering felt by one member of the family of nations is shared in more or less by all. The Lancashire weavers probably suffered more from the stoppage of the cotton supply in our civil war than they would have done by any contingency in a war between England and Germany or France.

THE researches of Mr. Charles B. Plowright into the distribution of calculous disease in England make apparent a correspondence between it and gout, and some likeness with the distribution of diabetes, but little or no parallelism with that of rheumatism and albuminuria. When compared with the rainfall map of the country, the disease seems to prevail most where there is least rain. So in Ireland, where the rainfall is very heavy, fatality from calculus is rare. Exposure to a dry atmosphere means, of course, more loss of fluids to the body than immersion in a moist atmosphere; and it has been proved experimentally that immersion in water of a lower temperature than the body of itself lessens the acidity of the urine.

SEVERAL agencies deleterious to health are mentioned by M. Raymondeau as confronting the workers in Limoges china-ware. They are forced to occupy a position that promotes a spinal curvature; the dust arising in the early operations of crushing and grinding the quartz is deleterious to the lungs; the work in preparing the paste is done on a panned floor over which water flows continuously, or under conditions favorable to the propagation of the maladies of dampness; those who have to place the prepared paste in the ovens are exposed to the danger of an escape of sulphuric-acid gas; and those who turn, polish, and dust the china suffer from the action of dust on their bronchial tubes.

SOME interesting facts were furnished some time ago by English hatters respecting the sizes of men's hats. The "size" is a mean between the length and breadth of the hat; thus, measurements of seven inches and a half by six inches and a half would give No. 7, and so on. The usual size for an adult Englishman is No. 7. Germans have round heads, Malays small ones. The heads of Portuguese average from six inches and seven eighths to seven inches; those of Spaniards are a little larger. The heads of Japanese excel the English average. Men that have much to do with horses are said to have the smallest heads; and a rough relation appears to exist between the size of the headdress and the mental capacity.

AMONG the peculiar geological features of Palestine, as described by Prof. Hull, are traces of old sea margins two hundred feet above the present sea margins, and the evidences that an arm of the Mediterranean had at one time occupied the valley of the Nile as far as the First Cataract, when Africa was probably an island. It is also made probable that, at the time of the Exodus, the Red Sea ran up into the Bitter Lakes. In illustration of the great changes that have taken place in the elevation of the land eastward of these lakes, it was mentioned that the waters of the Jordan Valley once stood at 1,292 feet above their present height.

A SMALL exposure of peridotite in Pike County, Ark., described by Messrs. Branner and Brackett, of the State Geological Survey, is regarded as important in the suggestion it offers respecting the time and character of the disturbing influences by means of which the region was sunk toward the end of the Cretaceous period beneath the ocean, and as interesting because it is the third reported occurrence of picrite-porphyry in the United States. The entire exposure is 2,400 feet long by 1,600 feet wide.

A MEETING of the International Congress of Hygiene and Demography is arranged for, to be held in London in 1890. Sir Douglas Galton is president of the organizing committee.

THREE asteroids which have been discovered since the 1st of January, 1890, bring the number of these worldlets that have been identified up to 290. Most of the more recent discoveries seem to have been made by specialists who pursue the search for asteroids as their chief work. Mr. Luther, who discovered No. 288, has been about forty years at the business, and this is his twenty-fourth planet. M. Charlois, the discoverer of No. 289, has detected six of these. No. 290 is M. Palissa's seventieth asteroid, although he has been looking for them only since 1874. Mr. Peters, of Clinton, New York, has discovered forty-eight. The brothers Henri discovered seven each, but of late years their attention has been turned from this subject to that of photographing the sky.

THE collection of birds from the Galapagos Archipelago, made in connection with the voyage of the steamer Albatross in 1882, is of special interest, for the reason that two islands are represented in it upon which no collections had been made before; and several new species have thus been added to science; while other islands have been carefully examined. From Mr. Robert Ridgway's description of these collections—published among the Scientific Results of the Expedition—it appears that the avifauna of the islands is not yet exhausted as a field for promising research in the problem of the derivative origin of species.

PRESERVING fruits and vegetables by drying in the sun has been practiced from time immemorial. Within historical times drying in kilns has been introduced, and within the present century compression of the dried product has been added to the process by the French. Immense quantities of dried and compressed fruits and vegetables are prepared for the British Army and Navy. In the Crimean War the following proportions for mixed vegetables were decided upon and are still adhered to: potato forty per cent, carrot thirty, cabbage ten, turnip ten, and seasoning herbs (onion, leek, celery, parsley, parsnip, etc.) ten per cent. The vegetables are also put up separately to meet special wants in various parts of the British possessions. After being dried they are compressed to about one eighth their original bulk, and formed into small slabs which are packed in soldered tins stamped inside with the year of manufacture.

THE American Geologist states that the largest gold-mine in the world is in Alaska. It is lighted throughout by electricity and is worked day and night. An offer of sixteen million dollars for this mine has been refused.

OBITUARY NOTES.

THE death of the German Count Keyserling made a large breach in the little circle of working araneologists, or students of spiders. It was known that he had left a large amount of manuscript for the concluding parts of his work, Die Spinnen Amerikas, and this, it was feared, would be lost to science. But the publishers, with praiseworthy enterprise, have resolved to complete Keyserling's work as far as possible after his original plan. They failed, however, to find any one in Europe who would edit the finished manuscripts and complete the fourth volume, which treats of the *Epeiridæ*. In this emergency they solicited the aid of Dr. George Marx, of Washington, D. C., who has at last consented to undertake the task. Being a thorough German scholar and a well-furnished araneologist, Dr. Marx is admirably equipped for this duty. A large part of Count Keyserling's manuscript, which was in a good degree of forwardness, has already been edited and will soon be ready to transmit to Germany. Dr. Marx will then edit the notes upon the *Orbitelariæ* and add descriptions of the species which Keyserling had not reached at the time of his death. He will thus contribute about one third of the matter in what will constitute Volume IV of Die Spinnen Amerikas.

EUGÈNE PELITOT, an eminent French chemist, died April 8th, in the eightieth year of his age. He was most distinguished in the field of agricultural and economic chemistry. As a pupil of Dumas, he published his first paper in 1836, on wood-spirit and its derivatives. He was Professor of Chemistry successively in the *Ecole Centrale* and the *Conservatoire des Arts et Metiers*, and of Analytical Chemistry applied to Agriculture in the National Agronomic Institute; and for forty years held a responsible position at the Mint. He first isolated Uranium. He was author of eighty papers on subjects of mineral and organic chemistry that bore relation to pure science, industry, agriculture, and hygiene. The most important of these were on the sugars.

SIR JOHN HENRY LEFROY, a British officer distinguished in military life and in science, died in Lewarn, England, April 11th, in the seventy-ninth year of his age. He was Director of the Magnetical and Meteorological Observatory at St. Helena in 1840 and 1841, and removed to a similar position in Toronto in 1842. During the next year he made a magnetic survey of the interior of North America from Montreal to the Arctic Circle. In 1854 and 1855 he was scientific adviser to the Duke of Newcastle at the War Office on subjects of artillery and inventions. He has since held several high military appointments.

AMONG the deaths of scientific men since the beginning of the year, which have not been specially noticed here, are those of Dr. L. Taczanowski, of Warsaw, author of works or papers on the ornithology of Peru, Poland, Siberia, and Corea; Otto Rosenberger, of Halle, best known in connection with his work on Halley's comet; Prof. Neumayr, the geologist, of Vienna; Dr. Gulia, Professor of Botany, Hygiene, and Forensic Medicine in the Royal University of Valetta, Malta, and author of a flora of that island; Dr. F. Hauck, algologist, and author of the volume on marine algæ in the new edition of Rabenhorst's Cryptogamic Flora of Germany; Lorenzo Respighi, of the Campidoglio Observatory, Rome; and Father Stephen Joseph Perry, of the Stonyhurst Observatory, England, who died in Demerara, where he had gone to observe the eclipse of December 22, 1889.

MR. JAMES NASMYTH, the eminent English mechanical engineer and inventor of the steam hammer, died in London, May 7th, aged eighty-two years. He was born in Edinburgh, the son of a distinguished artist. When a boy he made a small steam-engine for grinding his father's colors. In 1829 he became an assistant to Mr. Maudsley in his private workshop in London. After Mr. Maudsley's death he made himself a set of tools and began business, with a small capital, at Manchester. Besides the steam hammer he invented a safety-ladle for foundries, a ventilator for mines; a steam-engine for screw steamers, and a rolling-mill. He retired from business in 1857 and became an amateur astronomical observer, giving particular attention to the sun and the moon, and to astronomical photography. His monograph on the moon, prepared in conjunction with Dr. Carpenter, of Greenwich, is the most valuable English work on the subject.